THE HALF-TONE PROCESS

JULIUS VERFASSER

THE HALF-TONE PROCESS.

THREE-COLOUR BLOCKS BY
THE ARC ENGRAVING CO., LTD.,
4, FARRINGDON AVENUE, E.C.

THE JESTER.

THE HALF-TONE PROCESS.

A PRACTICAL MANUAL OF PHOTO-ENGRAVING IN HALF-TONE ON ZINC, COPPER, AND BRASS.

BY

JULIUS VERFASSER.

THIRD EDITION. ENTIRELY REWRITTEN

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PREFACE TO THIRD EDITION.

THE kindly reception which this book has met with in its previous editions and the universally flattering opinions of the press have been most gratifying to the author, and have encouraged him to endeavour in the present edition to make the book as complete as possible, so that it may be relied upon as a thoroughly practical and sufficient guide to the processes described. The author conscientiously believes that nothing has been omitted that is necessary for the working of the half-tone and kindred processes, but the reader is assumed to have at least a knowledge of ordinary photographic methods. The book will be found to be widely different from the first and second editions, having been almost entirely rewritten and new blocks supplied; but this was necessary owing to the immense progress which has been made in this process, and the improved methods of working which have been introduced in the seven years which have elapsed since the publication of the second edition. As before, the author has refrained from entering into theoretical considerations; but a concise and simple statement has been given of the principle underlying the action of the half-tone screen. This, the author thinks, will be sufficient for all practical purposes, and advanced workers can readily find sources of information on the theory of the process if they desire to study it. The additional

chapter on the three-colour process does not pretend to cover the ground of that development of the process, but simply indicates where and how the ordinary half-tone process merges into the three-colour method. It may be desirable to point out that the half-tone process as worked in America, in England, and on the Continent, differs in detail and in regard to the apparatus used; but the reader who has studied the different methods will readily see that they amount to the same thing, and the processes are all substantially as described in this book. Thanks are extended to the various firms who have lent blocks to illustrate the text, and also to those firms who have kindly contributed specimens of their processes, which greatly add to the interest of the book. In all cases I believe these favours have been duly acknowledged. It is not impossible that this book may have its shortcomings, but at least it is an honest attempt to furnish trustworthy information on this now important and useful process. The author has sought no personal credit from its publication, and is content to subscribe himself as before,

JULIUS VERFASSER.

PART I.

THE STUDIO, FITTINGS, TOOLS, AND APPLIANCES.

CHAPTER I.

WHAT IS HALF-TONE?

IT is desirable that the reader of this book, who, it may be assumed, is entering upon the practice of this process without previous knowledge, should have a clear conception of what is meant by the term "half-tone" in its application to the making of blocks by photographic processes.

Now, in a photograph, or in a black and white drawing, the shades of colour between light and shadow are termed "half-tones," and it is only possible to reproduce these half-tones in relief blocks for letterpress printing by means of a graduated grain, or by fine lines, or by tiny dots of varying size.

The "half-tone process," as commonly understood, is a method by which half-tones are reproduced in fine dots of varying size, formed by means of a network of lines ruled on glass and placed in front of the sensitive plate when making the photographic negative.

It would, on first consideration, seem probable that the effect of placing the network of lines in front of the plate would be to cut up the image into tiny squares, which would be all of the same size, only varying in density according to whether the square

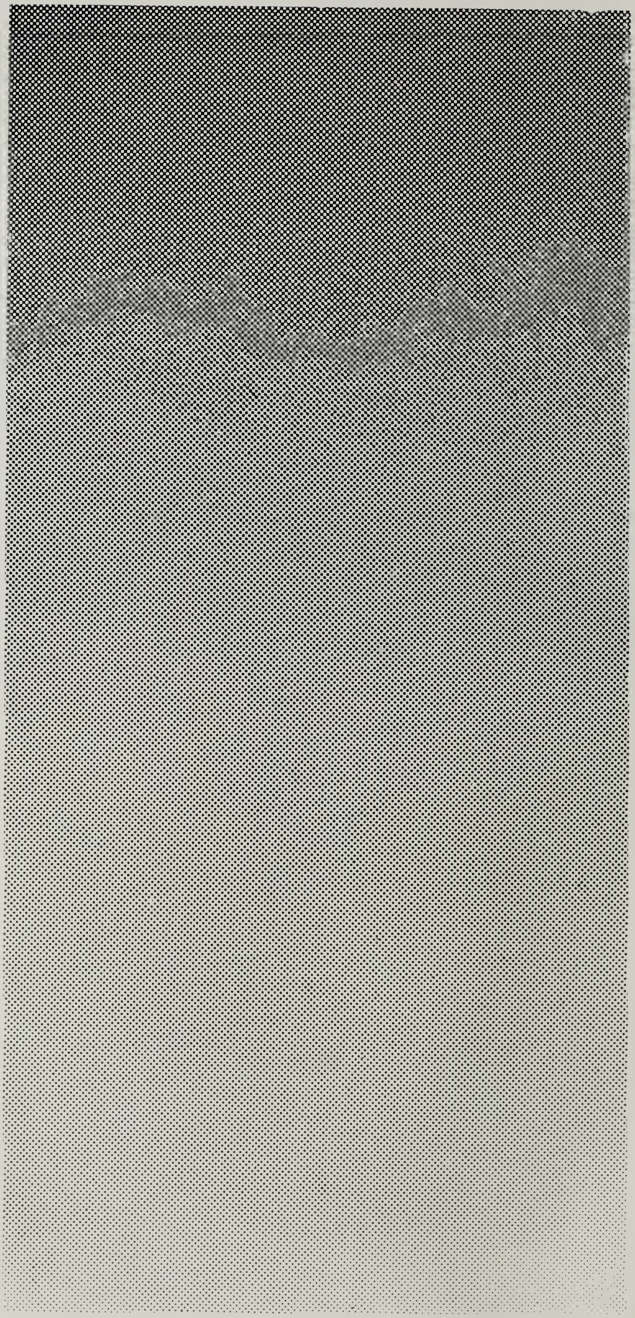


FIG. I. HIGH LIGHTS TO HALF-TONES. PHOTOGRAPHED FROM A GRADUATED TINT.

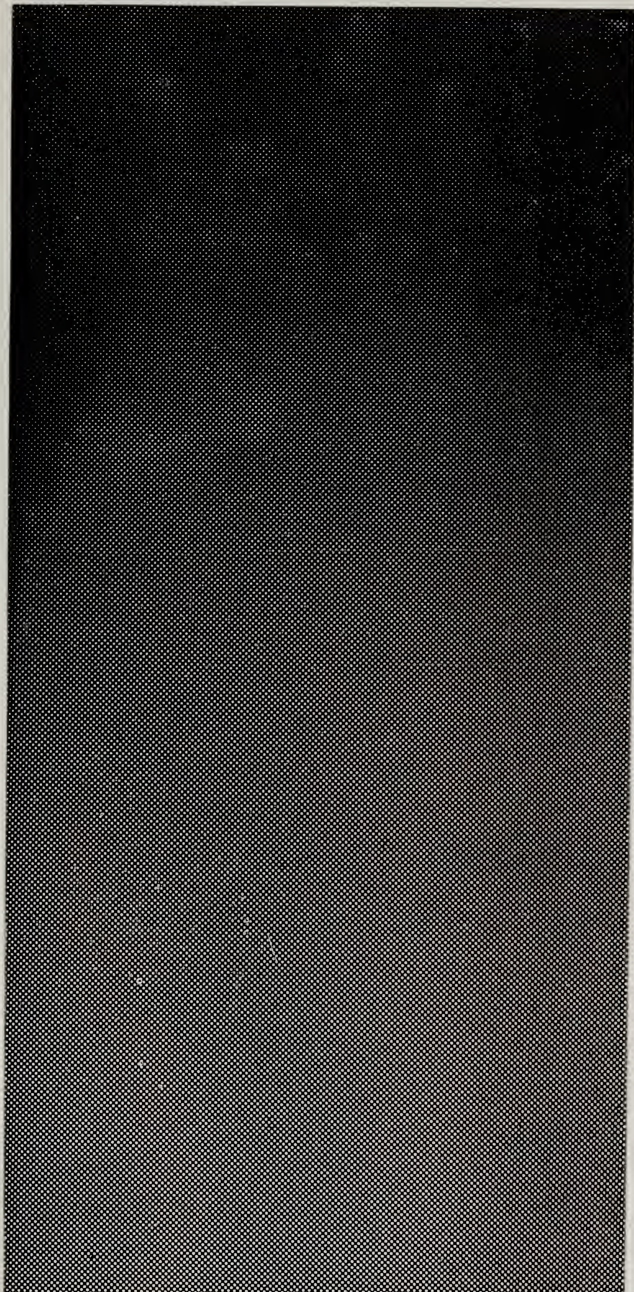


FIG. 2. HALF-TONES TO SHADOWS. PHOTOGRAPHED FROM A GRADUATED TINT.

happened to be in a light or a shadow, so that when the negative was printed the print would be simply covered with black lines, and the picture only imperfectly seen through them.

As a matter of fact, however, by suitable manipulation, which it is the object of this book to describe, the image is broken up into dots which are of varying size but of equal density—just the opposite to what we have been led to expect, but an effect which exactly suits our purpose.

Let us stop to consider for a moment what we require in a relief block for letterpress printing. It must present a level surface to the inking rollers and the impression cylinder. We cannot roll more ink on the darker shades of the engraving, and less ink on the lighter parts; the ink rollers deposit an even film of ink on the block. But if the lights of the picture are hollow spaces and the shadows are solid parts, level with the surface, whilst the half-tones are formed of dots of varying degrees of fineness, we shall surely get an equivalent for our inability to deposit more or less ink on the various parts of the block. These little dots will present different areas of surface to the rollers, and will, consequently, graduate the tones of the picture from the solid black of the shadows until they melt away into extremely fine points, which, to the naked eye, are indistinguishable from the white ground of the paper.

To make the matter clear we give on pages 14 and 15 on an enlarged scale a piece of a half-tone block

showing the varying degrees of dots from high lights to half-tones (fig. 1), and from half-tones to shadows (fig. 2). If these pages are placed at such a distance from the eye that the dots are no longer visible, the effect will be simply that of a tint graduated from black to white. By using a sufficiently fine network to produce this dot effect we render the dots practically invisible to the naked eye when the page on which they

Fig. 3.

are printed is held at the usual distance from the eye when reading. This will be judged by viewing the next example (fig. 3), which is produced with a network of 150 lines to the inch.

An examination of any of the examples of half-tone work in this book with a powerful magnifying glass will also enable the reader to understand fully that the picture is built up purely of a structure of dots of varying size.

It is most important that this principle should be thoroughly grasped, as well as the fact that the negative is nothing more than the reverse of this, consisting of a black ground with transparent spaces—a kind of stencil plate—the holes corresponding to the dots to be printed in ink on the paper.

Thus, it can be readily seen that if we coat a piece

of polished metal, such as copper or zinc, with a substance which is sensitive to light, and which, on account of that property, becomes so hardened that the portions acted on by light cannot be washed off the plate by bathing it in water, we can lay the negative on such a plate and expect to get a picture on the metal surface in insoluble dots, the unaffected chemical substance between the dots being washed away.

If, further, we can harden these dots to such an extent that they resist acids or some chemical solution which attacks and eats away the metal, we have got all the

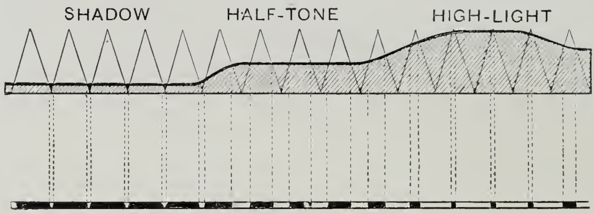


Fig. 4.

elements required for producing a block in relief. The space surrounding the dots is etched away, leaving the dots standing up as little pyramids with a flat top, which is larger or smaller according to the size of the pyramid. All the tops have, of course, the same level, and stand practically the same height from the base line, but they have different areas. This will be best understood by an inspection of fig. 4, the lower part of which may be looked upon as an enlarged section of the plate.

The reader who is familiar with photographic operations will probably begin to think now that the making

of half-tone negatives, and therefrom blocks, is a remarkably simple operation. But when he tries to make a negative in this way he finds that something more is required to be known concerning the action of this apparently simple network of lines called "the screen." His first attempts invariably result in the production of lines instead of dots, and he will find it is necessary that he should know something concerning the underlying principles of the process before he can become successful. We will accordingly proceed to give a simple explanation of the way this peculiar dot effect is attained.

Why it is that a network of black lines placed in front of the sensitive plate forms dots of varying size, but equal blackness, instead of simply cutting up the image into little squares of unequal density, is a problem which, even yet, is not adequately explained, though many elaborate theories have been advanced to account for it. We know the practical man does not like the word "theory," and we shall abstain from using it. It will be quite sufficient for the needs of the practical worker to state a "principle" which will be sufficient for his guidance in everyday work, letting his own inclination lead him to a deeper investigation.

Almost all of us have been familiar from our school-days with the action of the pinhole camera, in which the rays of light from different parts of external objects passing through the pinhole form an image at the back of the box. It does not require a great stretch of imagination to conceive each aperture in the network of the ruled screen as the front of a pinhole camera, and

the sensitive plate surface as the back of this camera, whilst the spot of light formed by the opening in the diaphragm of the lens is, for the case we are considering, an external object to this pinhole, sending rays of light towards the latter, so that the spot is focussed on the sensitive plate, where it forms an image which is afterwards developed to a black dot. Fig. 5 illustrates this action. That something of this kind actually does

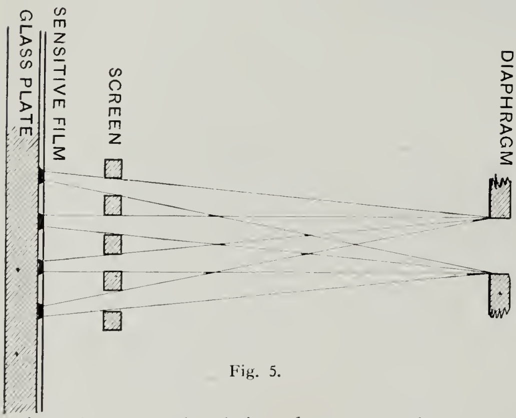


Fig. 5.

occur is proved by the fact that if the diaphragm opening is made square the dot is rendered approximately square, the same applying to any other form of opening which is sufficiently marked in shape to be readily distinguishable.

So far, then, the principle is intelligible and apparently obvious; but the weak point about it is that the production of larger or smaller dots to form the image is not explained. The reader will, however, quite understand that if, instead of any picture being presented to the lens, there was only a white sheet of paper, the dots would all be of the same size. Does it not, therefore, seem logical that if half the paper was covered with a black* sheet, the dots corresponding to this part would be small? Further, if another part of the white surface

* Even black paper reflects some light, and therefore produces dot effect, the size of the dots being dependent on the relative intensity of the illumination.

was covered up with something of a medium shade, neither black nor white—in fact, a half-tone—does it not occur to the reader that the dots would be of medium size?

That is practically what happens, but to assume this we must suppose that each dot starts with a nucleus which grows with greater and greater intensity of light or longer exposure. If we examine a negative under a powerful microscope we find that is exactly what does occur. Fig. 6 is a portion of a negative very greatly enlarged, and it shows clearly that each dot is, so to speak, a little mound of reduced silver.

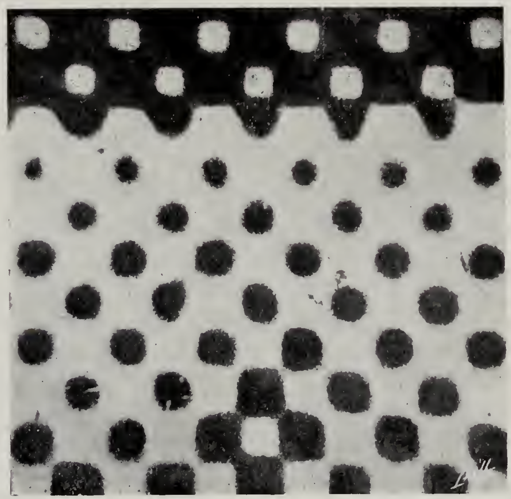


Fig. 6.

It may be that there are other causes operating to assist in producing this effect—for instance, the natural tendency of the silver particles to communicate their action to neighbouring particles, and to spread the image according to the intensity of the light and chemical action; whilst there may be also causes acting in opposition to retard this action and produce sharply defined dots with clear spaces. Diffraction is known

to have considerable action, but its phenomena are difficult to explain, and it hardly seems profitable to go into these bypaths of scientific speculation, if the pinhole idea is sufficient to serve our purpose as a working principle.

Our conception of a pinhole camera naturally requires that there should be some distance between the pinhole and the receiving surface, and this we actually get in practice, for the ruled lines of the screen are on the inside of two glasses sealed together, so that there must be the thickness of the glass in any case, even if the screen is placed in close contact with the sensitive plate. As a matter of fact, it is found that some distance is desirable and even necessary, as, by varying the distance, the spreading of the dots and their ultimate sharpness can be controlled.

It also follows, as a consequence of the pinhole idea, that the size of dot must be to some extent governed by the size of the diaphragm opening, which, as we have shown, is the object the pinhole is photographing. Further, it must result that the size of the dot image must be determined by the distance away at which the spot of light is situated.

It does not seem really necessary to carry the analogy any further, as all we have assumed accounts so far for every step which will be found in practically working out the process.

Mathematical calculations bear out the suppositions, showing that there is a correct distance for the screen

for obtaining the best effect, and that it is governed by the size of the diaphragm aperture, the size of the screen aperture, and the focal extension of the camera. It is very soon found in practice that the stop may be too large, so that it produces blurred dot images; or, on the other hand, the screen may be set too far away, so that the dots merge into one another, leaving no transparent spaces. Also, it will be found that, in the case where the screen is set too close, the cross-line effect is obtained. The various rules for avoiding these abnormal results and obtaining the best effects will be described in later chapters, and we will proceed now to discuss the accommodation and apparatus required.

CHAPTER II.

THE SCREEN.

THE screens now universally in use are cross-lined with transparent squares between the intersections of the lines. Fig. 7 shows a portion of a screen of 200 lines to the inch greatly magnified. The edges

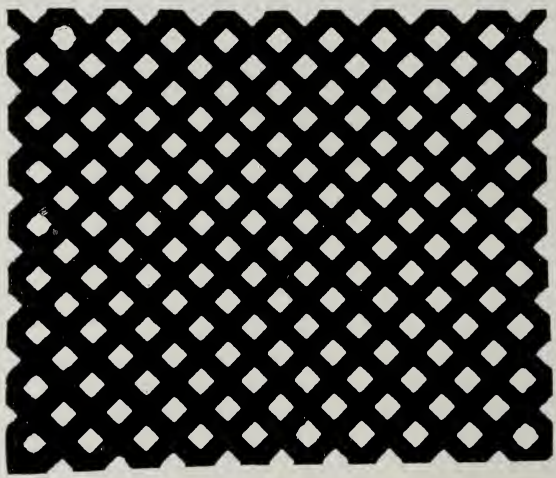


Fig. 7.

of good screens are sharp and clear under a magnifying power of 100 diameters. It was formerly the practice to use a single line plate, and to reverse the direction of the ruling by turning the plate a quarter revolution during the exposure, but this method is now obsolete.

Screens formed of circular dots instead of lines have also been tried, but abandoned by all practical workers.

HALF-TONE MADE
WITH MAX LEVY'S
400 LINE SCREEN.

ETCHED ON COPPER
BY THE ENAMEL
PROCESS BY THE
WALKER ENGRAVING CO.,
NEW YORK.

Grained screens and "chess-board" screens offer more promising alternatives to the half-tone screen, but at the time of writing they have not come into commercial use.

The old plan by which the operator made his screens by copying the proof from a copper plate engraved with parallel lines has also been quite superseded, as also the clumsy makeshift of using wire gauze, silk net, muslin, crape, or tulle.

The choice of a screen really becomes a simple matter, owing to the limited number of makers. Levy, of Philadelphia, U.S.A., and Wolfe, of Dayton, Ohio, U.S.A., are the oldest established ones; but very good screens of a similar character were put on the market recently by Johnson, of Leicester, and Haas, of Frankfurt-on-the-Main. The author knows of no other screen makers of importance.

Levy screens have undoubtedly the highest reputation, and are the most extensively used throughout the world. Their quality and utility are beyond question. In the Levy screens the lines are engraved in the glass by means of a diamond point, set in an engraver's ruling machine, which accurately spaces the lines to any desired number to the inch. The cutting is done through a waxen film, so that when completed the lines may be further deepened by exposing them to the action of fluoric acid, which etches the bare glass away, leaving the parts covered with the waxen film untouched. The furrows thus formed are filled in with an opaque black pigment. Two single line plates,

ruled in opposite directions, are generally taken and sealed together with Canada balsam, so that they form a cross-hatching.

Wolfe's screens were formerly copies made by contact printing from screens made by some similar method to the foregoing. They were evidently made on collodion dry plates, and were practically as perfect as an original ruling. An objection urged to their use was that, being formed of a silver photographic image, they were liable to lose density or become discoloured in course of time. This probably led Wolfe of late years to supply only engraved screens, which are certainly of excellent quality, and hardly distinguishable from Levy's.

Levy's "trial sizes," which are small pieces produced in cutting up larger plates, give the beginner a ready means of experimenting without incurring very great expense. The smaller sizes are in every way as perfect as the larger ones. Screen plates may be had from Levy from $4\frac{1}{2} \times 3\frac{1}{2}$, costing 10s., up to 40×32, costing about £200. Levy does not adhere to standard photographic sizes, cutting his plates from large sheets to best advantage. Thus, a plate bought as 10×8 will be quite $10\frac{1}{2} \times 8\frac{1}{2}$, so that the full area of the photographic size may be taken in. As a rule, the excess measurement over the standard photographic sizes is half an inch each way.

The question of the size of screen to be purchased must be determined by the size of the camera and the means of its owner, for large size screens are very

expensive. But the ruling is a matter which comes within the author's duty to advise. By the ruling is meant the number of lines to the inch. In determining what is best the intending purchaser must consider what class of work he is likely to do.

Plates ruled with any of the following numbers of lines to the inch can be obtained:

50	75	**100**	**133**	**175**
55	80	110	138	187
60	**85**	115	143	**200**
66	90	**120**	**150**	220
72	96	125	166	240

The numbers printed in blacker type are standard rulings, and are generally either in stock or partly finished, so that these can be always obtained with greater promptness than those of exceptional textures.

Levy has lately produced rulings successfully up to 400 lines per inch, and it has been found that typographic blocks made even with this degree of fineness can be satisfactorily printed.

The following rough classification of the various purposes for which the different rulings are suitable will be some guide to the choice of a screen, the most commonly used rulings being printed in blacker type. A general rule to remember is that coarse screens give most contrast, whilst fine screens give greater detail in the reproduction.

For large poster work ... ...50, **55,** 60 lines per inch.
,, rotary newspaper printing, stereotyped **66,** 72, **75** ,, ,,
,, flat-bed quick newspaper printing **85,** 90, 96, **100** ,, ,,
,, photo-lithographic transfers ... 110, 115, **120** ,, ,,

For commercial, book and periodical printing	125, **133,** 138	lines per inch.	
,, magazine and fine book printing	143, **150,** 166	,,	,,
,, hand-finished fine catalogue engravings	**175,** 187	,,	,,
,, microscopic reproductions and fine detail	**200,** 220	,,	,,
,, photogravure, heliogravure, intaglio plates	**240** to **400**	,,	,,

For average work there is nothing better than 133 lines to the inch, which makes a good all-round screen, neither too fine nor too coarse.

With regard to the proportion of black to white in the ruling—that is to say, how thick the black line should be compared with the transparent space between—there was formerly much divergence of opinion, but Levy now rules his standard screen with black lines and transparent spaces of equal width, and he no doubt follows the general demand.

It should be borne in mind in making any calculations based on the number of lines per inch that the figures give the "pitch" of the ruling, that is to say, the distance from the left hand side of one line to the right hand side of the next. The width of the line and the transparency space is accordingly half the "pitch" if the ruling spacing are equal. For example, if, the screen is 100 lines per inch, the line or space will be $\frac{1}{200}$th inch wide.

The standard screens are ruled with the lines crossing at an angle of 45° to the sides of the plate, but for special purposes screens ruled parallel to the sides, or to any specified angles, are obtainable. The 45° screen has the merit of making the screen pattern least obvious

to the eye on the finished print. A print produced from a screen with the ruling parallel to the sides will be somewhat harsh in appearance compared with the other.

Special screens for three-colour work are ruled at angles of 60° and 120°, or 75° and 105°. These unsymmetrical plates are made with both sides as nearly as possible uniform in thickness, so as to readily admit of use in obverse and reverse positions to make two of the blocks for three-colour work. If three impressions from 45° screens were superimposed, as in three-colour printing, a peculiar wave or moiré pattern would be produced. Hence the reason for choosing screens ruled at such angles as will obviate this.

It may be pointed out to relieve the beginner from any uneasiness as to the quality of his screen that in producing these screens it is impossible to avoid occasional small specks and bubbles inherent in all glass. These defects do not in any way affect the working quality of the screen, and though they are perceptible in the smooth unbroken tint of the screen, they frequently do not show at all in the resulting work. Where they do so they can be remedied by a touch of the graver in the hands of a finisher. The defects that occur from such small faults are of utter insignificance compared with those which occur through one or another extraneous source in the chemical manipulations.

Screens should be put away in a preserving box when out of use, and, being valuable, it is just as well to have them under lock and key to prevent accidents

from meddlesome hands. The surfaces should be kept perfectly clean, and in polishing care should be taken to avoid scratches. A very soft piece of washleather, an old cambric handkerchief, and a piece of soft tissue known as "papier Joseph," are things which suggest themselves as best to polish with. It must be borne in mind that a dirty screen will never give good results. When screens are used in the dark slide care should be taken that the edges do not get wetted with silver solution, otherwise it has a way of creeping in between the glasses, injuring the cementing, and giving a yellow stain.

Care must be also taken that the screen is not placed under any strain. It should not be "jammed" tight in its holder in the camera, nor when out of the camera should it be stood on end, or the outer glass may slide out of place in a hot studio through the cement softening. The screen should always be put away in a horizontal position between soft pads of cotton. Operators should avoid the practice of warming the screen, as is sometimes done to prevent the condensation of moisture on it from the wet plate in cold weather. The same effect may be obtained, as a rule, by rubbing a little glycerine on it and polishing off.*

It is one of the particular features of Levy screens that if they become scratched, stained, or unsealed, or partially broken, they can be sent back to the

* Recently a substance called "Cristalline" has been introduced for the purpose, and is highly spoken of. It looks like pomade.

manufacturer for repair at a nominal expense, and will be returned practically equal to new. Where one glass only is cracked, another can be matched to it, or where both glasses are broken at perhaps one corner, the screen can be cut down.

Of late, attempts have been made to rule screens which will break up the grain with less mechanical regularity. Levy has taken out a patent for such a

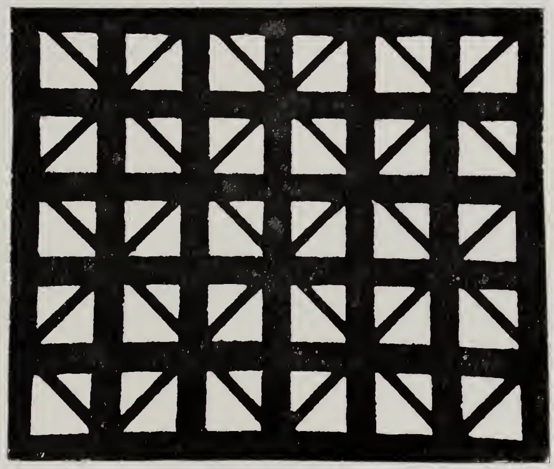


Fig. 8.

screen, in constructing which there are four sets of lines, instead of two as in the ordinary cross-line screen. Fig. 8 is an enlargement of such a screen. On each of the two glasses forming the screen is ruled a separate network. On the one glass the network is comparatively open and the lines thick, and it is ruled parallel to the sides of the plate. On the other glass the network is ruled at 45° to the sides of the plate, and the lines are thinner. The

two glasses are cemented together in such a way that the network of 45° cuts across the corner of the squares formed by the other glass. The result is the formation of groups of dots of irregular shape and size, so far as the elements of a group are concerned, but the groups are repeated geometrically. Yet such is the action of the light when the photographic image is passing through the screen that the mechanical continuity is broken. A greater amount of detail and better colour values are said to be secured.

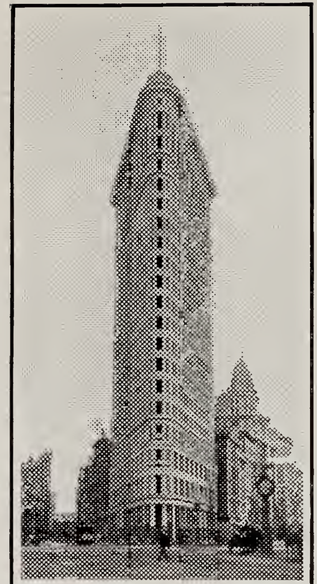
Levy, however, announces now that, owing to the great difficulties of producing these screens, he has abandoned their manufacture.

A peculiar effect of the four-line screen is that where a straight line is reproduced by the ordinary screen it will have a "saw-tooth" edge, whilst the four-line screen will reproduce it straight and clean to the eye.

Levy has also taken up the manufacture of a chess-board screen, a method of making which was originally patented by E. Deville. This screen has not at the time of writing come into general use.

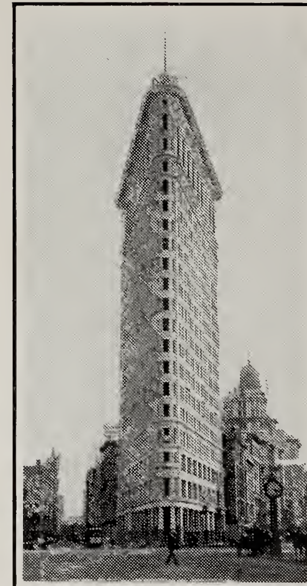
What are called irregular grain screens have been largely pushed of late years, but without their superiority over the cross-line screen being demonstrated. They can only be used as supplementary to the ruled screens for special purposes, and for suitable subjects.

As commonly understood, irregular grain screens



60 LINES

75 LINES.



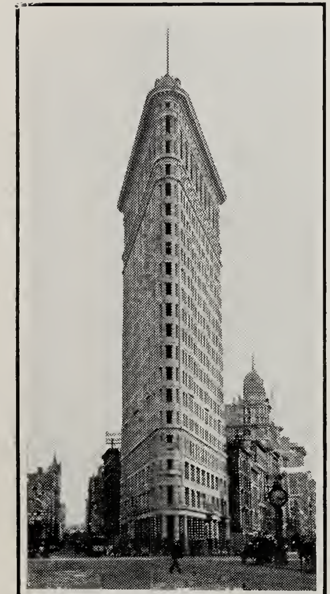
85 LINES.

THE "FLAT-IORN" BUILDING.

Corner of 23rd Street, and 5th Avenue, and Broadway, New York.

EXAMPLES OF COARSE HALF-TONES FOR NEWSPAPER PRINTING, MADE WITH LEVY SCREENS.

ENGRAVED BY
THE WALKER ENGRAVING CO.,
NEW YORK.



100 LINES.

133 LINES

150 LINES.

EXAMPLES OF MEDIUM GRAIN HALF-TONES FOR BOOK AND PERIODICAL PRINTING, MADE WITH LEVY SCREENS.

ENGRAVED BY
THE WALKER ENGRAVING CO.,
NEW YORK

175 LINES.

200 LINES.

400 LINES.

EXAMPLES OF FINE GRAIN SCREEN WORK FOR HIGH-CLASS PRINTING, MADE WITH LEVY SCREENS.

ENGRAVED BY
THE WALKER ENGRAVING CO.,
NEW YORK.

EXAMPLE OF WORK WITH
WHEELER'S FINE GRAIN
METZOGRAPH SCREEN.

PRINTED BY THE ENAMEL
PROCESS, AND ETCHED
ON COPPER.

are produced by depositing on a glass plate an opaque powder in such a manner that transparent spaces of varying size will be left between the grain points. Another way is to flow the glass plate with an opaque varnish so compounded that it splits up on drying into a reticulated grain. To give such screens a greater degree of permanency they have been etched and filled in with black pigment in the same way as the ruled screens, the grain first formed being of an acid-resisting nature.

Such screens cannot be regarded as acting in the same way as a ruled screen. They are placed as close as possible to the sensitive plate, the use of a cover glass not being permissible, and each grain point must be considered as an opaque obstruction to the light. The image spreads more or less according to the intensity of the light, so that in the highest lights all but the portions under the largest opaque obstructions are filled up, whilst these are closed to such an extent as to produce a very fine dot. A very small stop and long focus lens has to be used in order to restrain the spreading action.

A more promising kind of irregular grained screen, having, moreover, some peculiar optical features, is the Metzograph, invented by Mr. Jas. Wheeler. It has absolutely no opaque grain on it, presenting to the naked eye simply the appearance of a piece of ordinary transparent glass. On examination under magnifying power, and at a suitable angle to the light, it is seen that the surface is covered with prismatic

reticulations, the character of the grain being in many respects similar to collotype (fig. 9). It is stated that the process of production of this screen consists essentially in the sublimation of pyrobetulin, which, being deposited on the glass in a reticulated film of

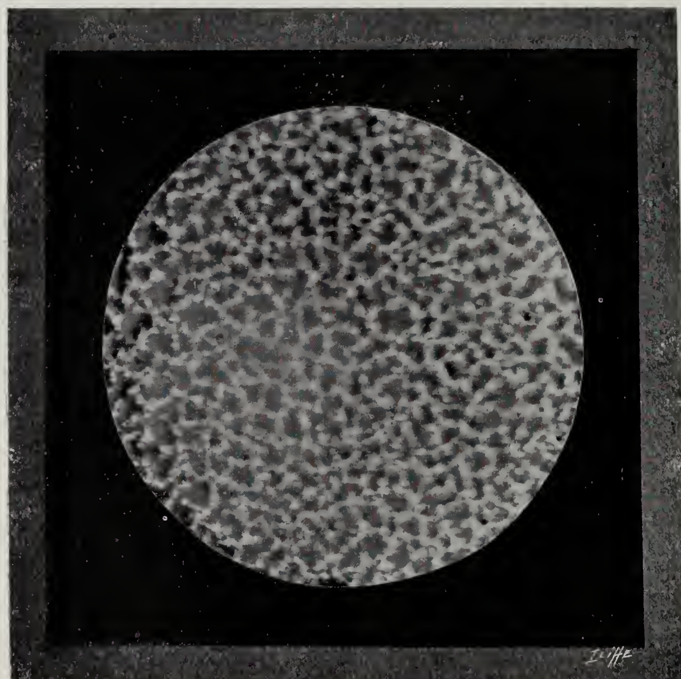


Fig. 9.

any desired fineness, is afterwards treated with hydrofluoric acid, whereby a like character of reticulation is imparted to the glass itself. The effect of the prismatic reticulations is to divert a portion of the light which reaches the screen, causing alternate light and dark spaces which have consequently the same

effect as opaque obstructions, but without the harshness which the latter seem to impart. Every tone of the picture will exert a different selective effect on the grain, and, consequently, a truer naturalness of texture and gradation is secured. The procedure for the production of the negative is similar to that followed with the lined screen, but the plate should have an exposure not exceeding one-sixth of the time necessary with a lined or pigmented grain screen. A small stop has to be used for the exposure, and the screen must be placed as close as possible to the sensitive plate.

Of course, for all ordinary work the usual cross-line screens will no doubt long remain in use, but advanced workers will very probably take up the interesting work of utilising these new screens.

CHAPTER III.

THE STUDIO: ITS CONSTRUCTION.

ANY studio built for photographic work will suit equally well for copying for the half-tone process; but where electric light is available any ordinary room of sufficient size may be used, and it is quite unimportant on what floor it is situated. In London and other large cities, process studios will be found in dark basements and all kinds of upper floors, the daylight being in many cases blocked out altogether.

There can be no doubt that there is nothing like good daylight after all for photographic work, but, unfortunately, it is not usually constant enough to suit the commercial requirements of half-tone work, which must be produced at all times of the day and night for illustrated newspapers. Most large firms who have studios outside the city compromise the matter by having them arranged for the use of both daylight and electric light, and undoubtedly this is the best practice, as daylight can be employed almost exclusively during the summer months.

There is frequently great difficulty in lighting large originals, and especially coloured originals, with the usual pair of arc lamps, where there would be no difficulty with daylight.

If it is necessary to build a studio it is most essential to determine, first of all, what size camera will be worked, and what is the extreme reduction likely to be required. Then, if the focus of the lens is known, the minimum length of studio can be estimated from the following table, which is based on the focus of lenses usually in use for cameras of from 12 x 10 to 24 x 20, the camera being placed for direct copying without prism or mirror.

Focus of lens.	Distance from original to ground-glass when copying to the following scales :							
	1/1		1/2		1/4		1/8	
Inches.	ft.	in.	ft.	in.	ft.	in.	ft.	in.
12	4	0	4	6	6	3	10	1½
14	4	8	5	3	7	3½	11	9¾
16	5	4	6	0	8	4	13	6
18	6	0	6	9	9	4½	15	2¼
20	6	8	7	6	10	5	16	10½
24	8	0	9	0	12	6	20	3
30	10	0	11	3	15	7½	25	3¾

It may be taken as a general rule that it is seldom that reductions below quarter size are called for, and it is a good plan to base one's calculations upon this limit, as one can put a shorter focus lens on the camera to deal with smaller reductions.

If we reckon two feet over and above the distance from the original to ground-glass we get the overall dimensions of the swing or copying stand, and it is generally necessary to allow a gangway of at least three feet at each end for walking round, so that on the whole it may be taken as a rough and ready rule to add eight feet to any of the above distances for quarter size

reductions to arrive at the size of studio suitable for a given lens.

Take the case of a lens for 15 x 12 work, which will be 18 to 20 inches focus, the studio length will be from 17 feet $4\frac{1}{2}$ inches to 18 feet 5 inches, according to our rule, and from the latter length up to twenty feet will be found to be the space allowed for a 15 x 12 camera in most good studios. Swings or stands for 15 x 12 cameras are usually made twelve feet long.

The next consideration will be the width of the studio. Here it must be borne in mind that it is necessary to work with a mirror or prism for reversing the negatives, consequently the camera must be placed across the swing or stand. If we have not the camera at hand to measure, we may take it that the base will be at least twice the focus of the lens. A 15 x 12 camera will generally have a base length of four feet, and as we must have plenty of room to walk past the camera at each end without pushing against it accidentally during an exposure, we would set down as a rule that one cannot work a 15 x 12 camera in less than six feet.

From the foregoing considerations it will be seen that the least floor space for a single camera of 15 x 12 size is 18 feet x 6 feet. When two cameras are worked together it will be found that less than twelve feet width will do, as they can have a common gangway between.

In the matter of height there is no rule to observe, but it is well to remember that a fairly lofty studio gives better ventilation, and can be maintained at a

more equable temperature. If it is intended to work the electric light as well as daylight, it is necessary that the studio should be rather high, in order to sling the lamps well above the camera. Overhead traversing gears are usually not manageable unless placed at a height of ten or twelve feet from the floor.

If daylight is used, it is naturally best that the lighting should come from the north, though any other position could be made use of with the aid of blinds to shut off any direct sunlight which might be likely to cause uneven illumination. Perhaps the best form of studio is one with a top light inclined towards the north, and also with glass at the east and west sides, the south side being closed and the copy-board being placed next to it. At the north end may be the dark room under the ordinary roof. Such a studio will present the appearance shown in fig. 10.

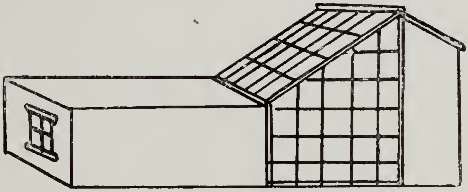


Fig. 10.

If side light cannot be obtained, the walls of the studio should be whitened, or white screens set up at each side.

It is not necessary to carry the glass on the roof the whole length of the studio; it is, in fact, better that the end of the studio where the camera is placed should be in comparative shade, so that the focussing may be done with ease.

The studio should be solidly built to prevent vibration,

though this may be overcome, as will presently be shown, by swinging the camera base or supporting it on springs. The beams supporting the roof should be strong, especially if the electric lamps and camera base have to be swung from them.

It is a mistake to assume that the best place for a studio is at the top of a building. Whenever space can be spared, it is best to have it on the ground, the floor being laid with concrete under the camera stand.

In some studios the camera is placed on a table stand with grooved wheels running on rails, and the copy-board either rigidly fixed against the wall or provided with a stand and grooved wheels to run on the same rails. It is not easy to secure parallelism with this arrangement, unless the camera stand is provided with a levelling arrangement, and the copy-board with adjusting screws. Unless there is an entire absence of vibration this separation of the support of camera and copy-board will give trouble owing to the two vibrating unequally. With the two joined by a long base there is a certain amount of springiness, and a tendency for the whole to vibrate together, and it is obvious that if the ground-glass and the copy-board are vibrating together, or, so to speak, in "step," there will be no evidence of movement of the image on the ground-glass, which, if present, would cause blurred and unsharp images.

It is for this reason that the plan of swinging the camera base with ropes or supporting it with springs is

resorted to, as we shall describe when we deal with the camera and its accessories.

A good bench or table in some part of the studio, especially just outside the dark room, is a convenience if space is available, as this can be used for glass cleaning and other operations requiring a good light. But it is desirable that no other operations than those appertaining to the taking of negatives should be performed in the studio, and the less it is lumbered up with odds and ends the better it will be for the cleanliness and comfort of working.

Provision must be made for warming the studio in winter, and for keeping it cool by proper ventilation in the summer time. An electric fan is very good for the latter purpose.

In some cases it may be possible to get hot water pipes through the studio, but in case this is not available a good gas stove is a convenient and cleanly means for warming. A coke stove is rather objectionable on account of dust created. An oil stove is a good substitute for a gas stove. Electric radiators are coming into use, and are not any more expensive to buy or to use than gas stoves, whilst, as the electric supply is to be found in nearly every studio, the radiator is easy to instal. Most electric supply companies give a special rate for current required for heating purposes.

The studio having been arranged on some such lines as we have suggested, we must next consider its equipment with suitable apparatus.

The primary consideration is the camera and its

accessories. In the early days of the process it was usual to take any ordinary camera of good square pattern—preferably one that had been constructed for copying—and make some provision in the dark slide for holding the "screen" in front of the sensitive plate. If the dark slide was not deep enough a new one was made with the recess for the plate at least double the usual depth. The "screen" was then placed in, and a strip of cardboard introduced round the margin so as to prevent the plate touching. The ground-glass had, of course, to be correspondingly set back in the focussing frame to agree with the position of the sensitive plate. An obvious disadvantage of this method was that any alteration of the screen distance, by putting in thicker cardboard strips, would put the plate out of focus, unless the ground-glass was correspondingly altered.

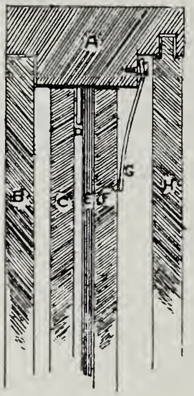


Fig. 11.

A—Framework of dark slide.
B—Back lid of dark slide.
C—Plate carrier.
D—Wire corner.
E—Cardboard separation.
F—Screen carrier.
G—Spring.
H—Shutter.

This difficulty was overcome by dividing the plate recess into two portions, as in the case of the double back of an ordinary camera. The division was effected by means of a thin silver plate or wire placed diagonally across the corners (fig. 11). The sensitive plate was then laid on one side of the division and the screen on the other, springs generally being provided to prevent the screen falling out. If any alteration of the screen distance was required a

piece of cardboard could be laid between the screen and the corner wires. Different sizes of screens can, of course, be placed in carriers in the same way as the plates. Screens are usually $\frac{3}{16}$in. thick, and in making a dark slide it is well to allow twice this depth for the screen carrier, so that an adjustment up to $\frac{3}{16}$in. may be obtained by the insertion of thicknesses of cardboard. It is better that the latter should be cut out like the mask of a lantern slide and the thickness a definite fraction of an inch, say $\frac{1}{64}$in. or $\frac{1}{32}$in., so that the combination of any number of these would give any pre-determined screen distance, which could, moreover, be accurately repeated at any time.

A dark slide arranged on the foregoing lines would be regarded in these days as a makeshift in any up-to-date establishment; nevertheless, it will suit very well for a beginner, who wishes to be very economical in his expenditure on apparatus.

A step better is to have a "screen and plate-holder," in which there is some mechanical means of adjusting the screen and thus dispensing with the cardboard packing.

Max Levy was the first to devise a successful holder of this kind for use with his screens, and the same, or modifications of it, are largely used in America to this day. The Levy holder practically doubled the form of wet plate holder known as the Benster or Bonanza, which was, and still is, very popular in America. The feature of this form of holder is that carriers are dispensed with, the plate being held between two bars,

which grip it like a vice. The bottom one is usually in notches at each side of the holder, corresponding to the bottom edge of the different sizes of plates, and the top bar slides down until it rests on the top edge

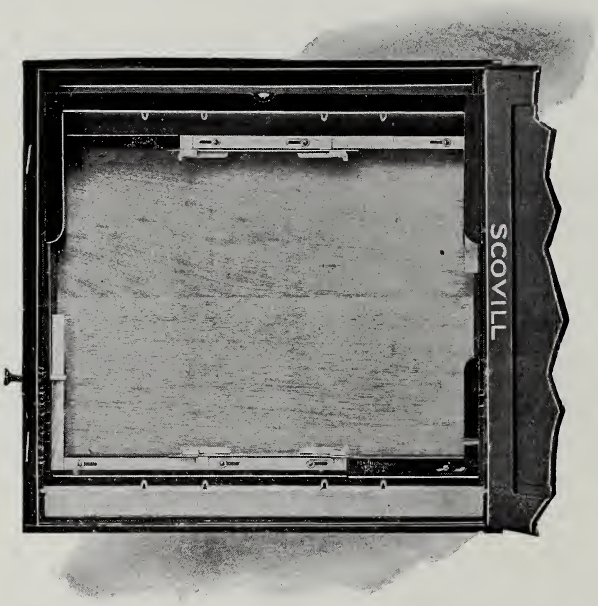


Fig. 12.

of the plate, as shown in the illustration (fig. 12). This is known as the Scovill-Levy holder.

In some forms of this type of holder, the bars have had attached to them a rack, so that a central pinion at the side would feed them up and down equally. Anthony's holder (fig. 13) is on this principle. In another pattern there is a rod at each side with a right and left-handed screw cut on it, so that when engaged with a nut on the bars they move to and fro

equally. These complications are, however, quite unnecessary, and are even objectionable where the wet plate process is worked, as the mechanism gets rusted or corroded.

For half-tone purposes two pairs of bars are provided, working independently of each other, one pair

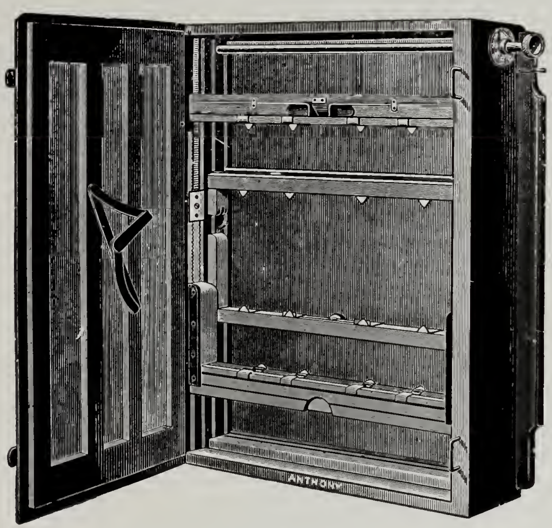


Fig. 13.

thus holding the screen and the other the plate—the screen, instead of resting directly on the bars, is held in clips attached to them. In the early forms of this holder these clips were attached to a sliding bar, which, when pushed one way or the other, altered the distance of the screen. The disadvantage was that either two or four corners had to be shifted separately and it was not easy to get the screen quite parallel, whilst the adjustment could only be done when the slide was open and apart from the camera.

Penrose and Co. improved on the idea by introducing a holder in which the screen was adjusted by turning one knob on the outside of the holder, and the distance moved was shown by a pointer working against an ivory scale plate. Two forms of this holder are made, one comprising the smaller sizes from $6\frac{1}{2} \times 4\frac{3}{4}$ up to 10×8, with ordinary carriers for dry plate work; and the other on Levy's principle, with the double pair of bars, for wet plate work, from 12×10 to 24×20. Such a holder could be attached to any ordinary camera, and forms a very efficient apparatus for half-tone negative making (fig 14).

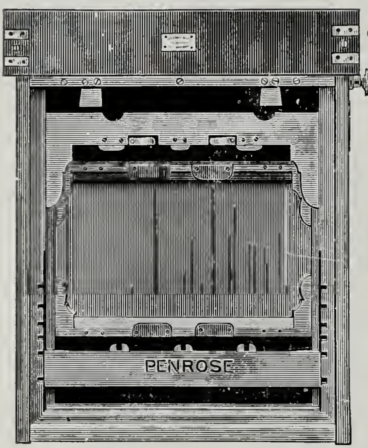


Fig. 14.

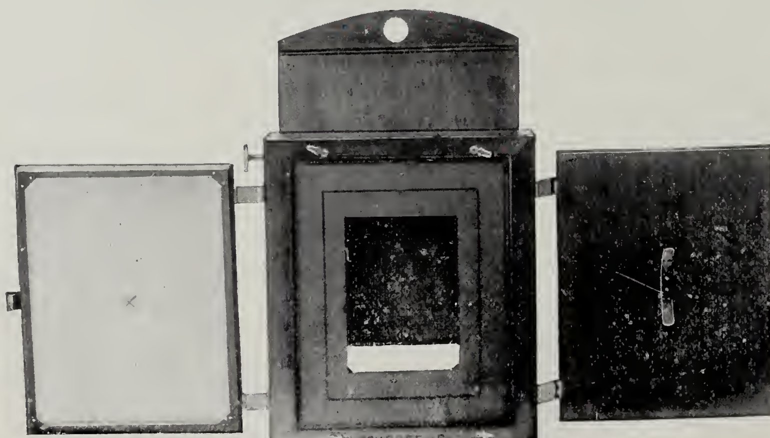


Fig. 15.

In the smaller sizes of these holders a ground glass frame is attached by folding hinges, so that the back of the holder may be opened and the glass swung into its place, the front shutter being drawn, and the holder becoming to all intents and purposes a focussing screen (fig 15). In the larger holders a piece of ground glass is placed in the holder, and the roller shutter in front is made to wind up into the top of the holder, so that in this case also the focussing may be done.

All these methods must be regarded as more or less makeshifts, which are not in any way comparable for convenience with the plan which has now become very popular—in Europe at any rate—of holding the screen independently of the dark slide in a frame which can travel to and fro in the back of the camera, thus enabling the screen to be racked into position after the dark slide is inserted. Penrose and Co. patented this idea about 1894, and their system has been extended and elaborated so that it now forms a very perfect mechanism for holding and operating the screen. The apparatus (fig. 16) consists essentially of a frame

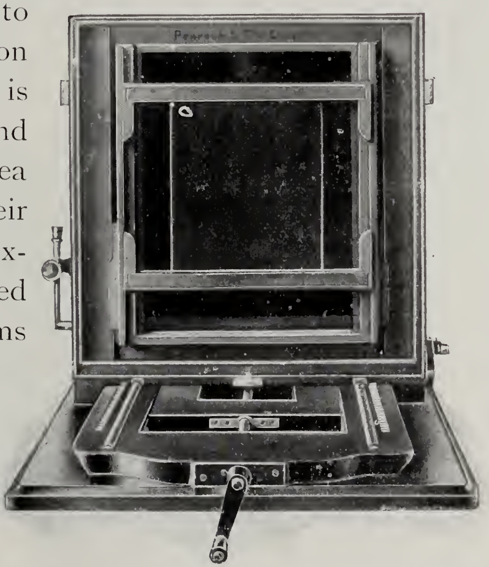


Fig. 16.

carrying a pair of adjustable bars to hold the screen, in a similar manner to that of the dark slides already described, this frame being attached to a pair of accurately fitting iron slides, running in brackets fixed at each side of the interior of the camera. The slides are operated by levers at each side, set in motion simultaneously by a rod, to which they are fixed, passing through the camera, and having on its outside end a lever for working it. This lever is sometimes provided with a micrometer screw for obtaining a slow and fine movement, and also affording a stop against which the lever can be returned without re-setting. A pointer projects from the inside travelling frame and indicates its position on a scale plate outside. This plate is usually marked off with two scales, one reading in millimetres and the other in $\frac{1}{32}$ parts of an inch. It is thus possible to set the screen very accurately to any determined distance from the sensitive plate, and the advantage is that the screen is kept safe against accidents, which may easily result from carrying it so often to and fro, and from manipulating the holder in the dim light of the dark room. Further, the screen may get scratched by the corner of the sensitive plate coming into contact with it, or just at the moment of inserting the plate a drop or splash of silver on to the screen necessitates taking it out and cleaning. But a worse trouble is that the silver solution which drains from the plate is apt to creep up between the sealed glasses of the screen by capillary attraction, not only causing a yellow stain thereby, but disintegrat-

ing the Canada balsam used for sealing, and causing the glasses to separate. It is impossible to use the part of the screen thus affected, and the only remedy is to send the screens back to the maker for cleaning and resealing, entailing long delay.

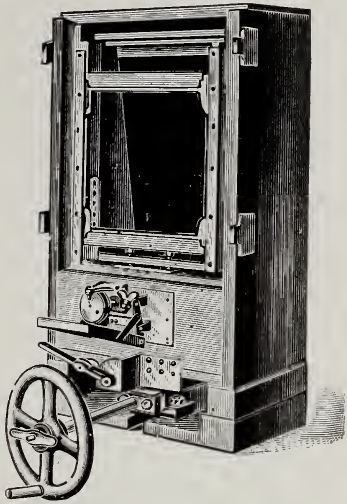


Fig. 17.

Several other makers have constructed screen adjustment mechanisms for the back of the camera, their essential points of difference being in the slides for guiding the movement and the means of operating it. Linley's patented system is perhaps the most notable and best known (figs. 17, 18). It consists of placing a single dovetailed slide, like the slide rest of a lathe, in the

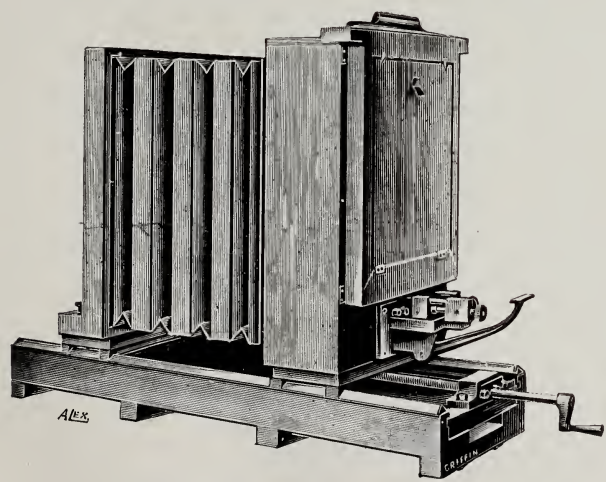


Fig. 18.

bottom of the camera body, and erecting the screen holding frame upon it. The slide is moved by a central lever operating a finger piece under the slide. This will pull it to and fro with a quick movement, whilst a micrometer screw operating against the sliding piece provides for a slow and fine movement.

Klimsch uses a similar slide, but operates it by a horizontal linked lever from the side.

Voirin adopts the same form of slide, but operates it by a screw.

Falz and Werner use the base plate slide in much the same way, and operate it by a pinion rod, with knob on the side of the camera.

Strivens, and also Watson, arrange a pair of bevelled cog wheels in each of the four corners of the screen holder, and operate these simultaneously by means of connecting pinions ending in a knob on the outside of the camera.

In a camera patented jointly by Penrose and Brown, in 1899, there were four cams attached to two rods placed near the top and bottom of the screen-holder, the rods being made to operate simultaneously from one knob on the outside by connecting them with a lever or chain or strap of metal. As the cams turned round they pushed the screen gear outwards, and by means of a flat spring attached to the holder and pressing against the back of the cams,the return motion was provided for.

The principle of a pair of wedges sliding parallel to each other, and also the principle of the parallel rule has been used.

Recently Penrose & Co. have constructed a screen gear which does away with both the side slides and the base slide, the holder being supported on four bell crank levers, which are attached to rods or brackets, connected with a strap or rod, and operated simultaneously by means of a lever outside. Still another variation is a sliding wedge-shaped strip which is pushed in and out.

There is probably not much scope now for any really new method of screen adjustment, so many notions having been tried. Most of the attempts to improve on the original idea have been with the idea of ensuring exact parallelism and freedom from risk of going wrong. One principle is common to all screen movements, viz., that there must be a quick to and fro movement, and a fine slow adjustment, each acting independently.

The camera in other respects is an ordinary camera, except that it is necessarily more bulky on account of holding the screen gear, and it must be made very rigid and parallel in all respects. The moving parts for focussing should run on metal slides, and there should be no side play, nor should the bodies rock vertically. The base should be in one length and proportionately thick to ensure freedom from bending when the weight of the bodies is on any particular part.

A camera with both front and back bodies moving is an advantage, especially when working extreme reductions with a large camera and a short focus lens. If the front body was fixed in such case, there would

be a long stretch of tailboard to lean over to get to the focussing glass. Fig. 19 illustrates a popular type, and the Linley camera, fig. 18, also finds considerable favour.

A camera, with back body fixed, and focussing with the front body, is difficult to focus, as the copy or the whole camera must be moved at the same time.

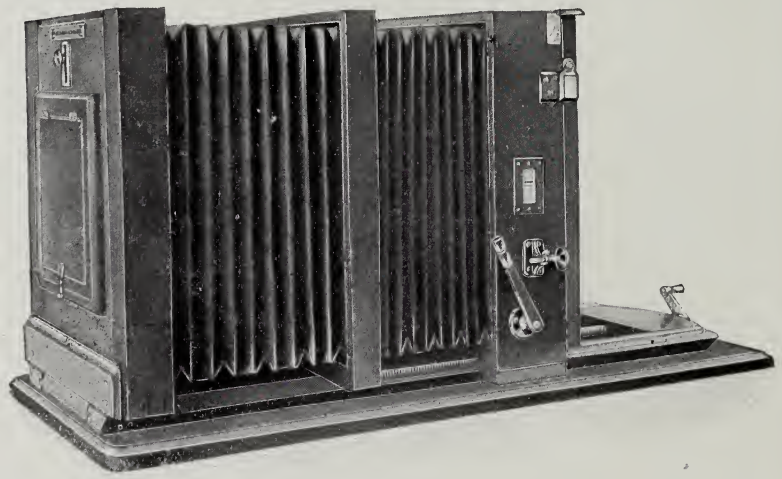


Fig. 19.

The best arrangement of all is to have a camera with both the front and back bodies movable. The front may be operated by a screw, and the back by a pinion, thus keeping the control of the movements to the back of the camera. An arrangement for raising and lowering the front by some means, also from the back of the camera, is a further convenience for centring the copy, and the plan of having all the

manipulations operated from one point may be extended to the luxury of having an additional lever to shift the lens-board or the copy-board laterally.

Attempts have been made to devise automatic methods of adjusting the screen, or of indicating its correct position, proportionately to the extension of the camera. Whilst such an apparatus is quite a possibility, and has been patented in two or three forms, there is not at the time of writing any apparatus on the market for the purpose, the fear being probably that the apparatus would prove too complicated to be useful. The most promising idea of this kind is an apparatus invented by Mr. Ray, of Calcutta, which seeks only to indicate the correct position of the screen, so that the operator may set it himself without having to think about the matter.

The apparatus consists of a pair of rods of equal length, looking very much like half of a pantagraph parallelogram. One of the free ends of these two rods is attached to a point opposite the sensitive plate, and the other to a point opposite to the diaphragm of the lens. A pointer placed on the rear rod then indicates increase or diminution of the screen distance proportionate to the extension or closing up of the camera. Such an arrangement implies, of course, the use of a constant size diaphragm or screen, but provision is made in Mr. Ray's invention for correcting the indication according to any alteration on these heads.

Next in importance is the base and copy-board.

Whether this should be in the form of a swing or a rigid stand depends on the nature of the premises. If the studio is at the top of a lofty building, or, indeed, on any upper floor, with machinery in the basement or on the lower floors, or if it is situated near a railway or busy thoroughfare so that a great amount of vibration is caused, it is necessary that the camera and copy-board be suspended on one bed frame from the beams of the roof, or swung, cradle-fashion, from

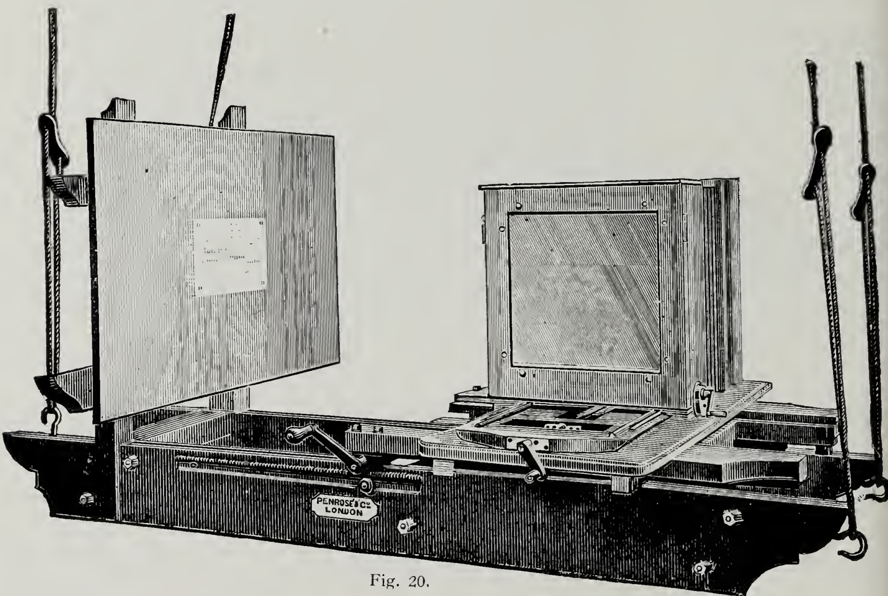


Fig. 20.

springs supported by a rigid stand. If the s situated quite away from any vibrating influence, a rigid stand on a concrete floor is best and most convenient to use. On a wooden floor it is possible to minimise vibration by placing thick rubber or felt pads under the feet of the stand.

Fig. 20 illustrates a swing of the usual form, and fig. 21 illustrates a swing used with the Linley camera, the feature being that as the camera front is focussed the copyboard is automatically centred—a rather unnecessary complication. Some workers attach the upper ends of the four ropes to a beam which is swung at its centre, like a scale beam, from a single hook in the ceiling. This, I think, is not a good

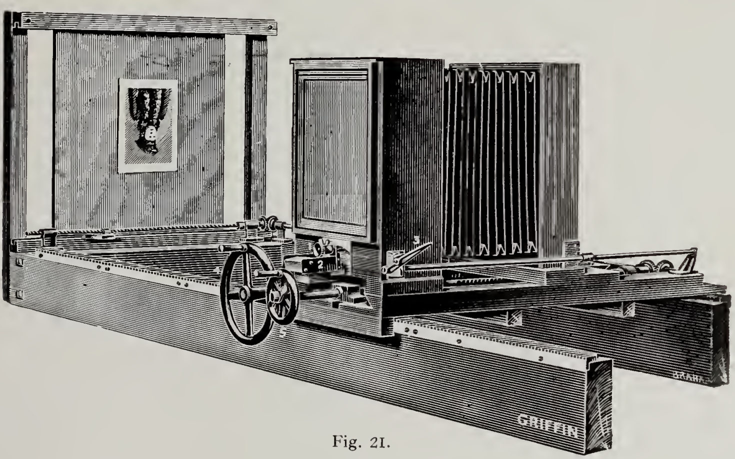


Fig. 21.

arrangement, as it is difficult to keep the camera steady while focussing, and also it is not easy to preserve the balance, though this is sometimes adjusted with a sliding weight. The only practical advantage that has been claimed for this form of swing is the possibility of twisting it round to suit the changing direction of the sunlight. But in such a case a very large studio would be required if the swing were any considerable length.

A better idea is to have the beam suspended by

two hooks, which secure equilibrium in the longitudinal direction, and the balance can be easily preserved in the transverse direction. There is certainly a gain in using less than four hooks, as it is found that if one rope is more in tension than the others a strain is set up which causes vibration. Three hooks are better than two or four, as they follow the principle of the tripod in finding a level and preserving equilibrium. Springs inserted between the ropes and hooks are good for absorbing any chance vibrations, and also neutralising the effect of the ropes becoming hard and inelastic by constant tension.

The author considers a spring cradle stand preferable to the rope swing, being a perfect means of absorbing vibration, and having, so to speak, a clear deck when the camera is being worked near the end. The ropes are often found in the way in such case, and take off some of the effective length. It is much more easy to move the camera and perform the focussing operations on a spring stand. Another advantage is that it can be placed anywhere in the studio and easily moved again if required (fig. 22).

In the construction of such a swing base, or the cradle of a spring stand, there are one or two points to be considered. In the first place, it should be of stout timber, at least 6 x 3 inches for swings up to 10 or 12 feet, and 9 x 3 inches for swings up to 15 or 16 feet; for swings up to 18 or 20 feet, 11 x 3 inches should be used. Unless some such proportions are adopted the swing will probably sag in the middle

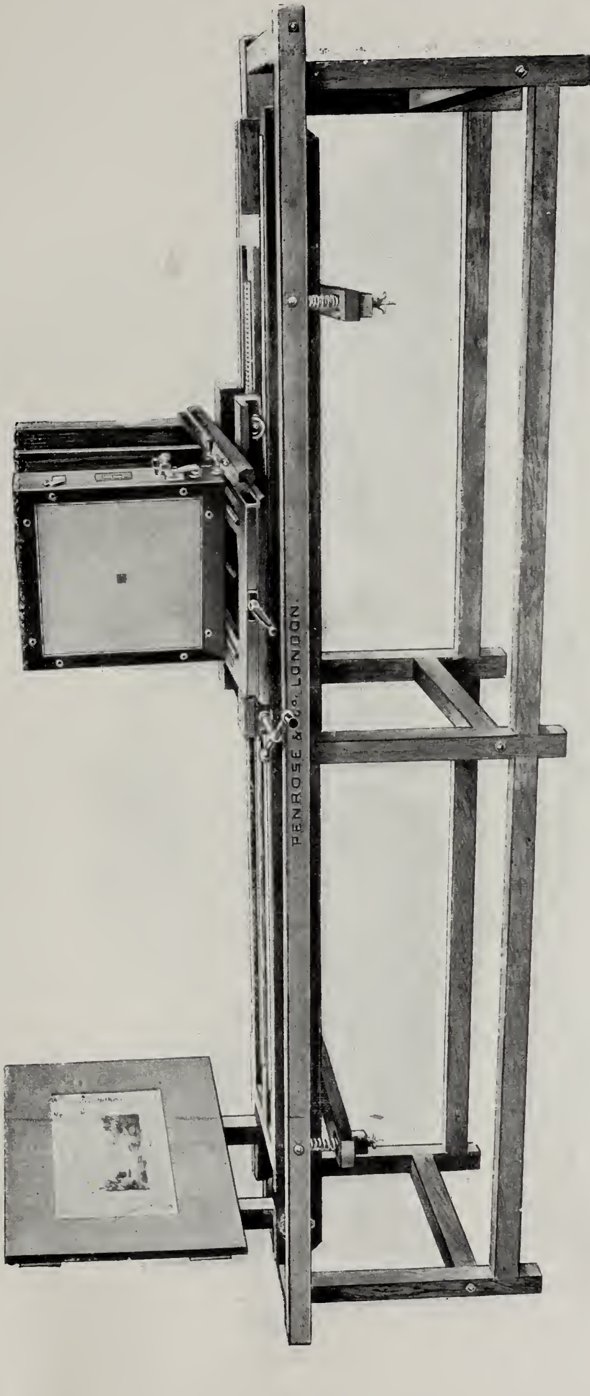


Fig 22

or twist in some direction. The timber should be carefully selected of well-seasoned yellow pine; if not thoroughly dry it will split or go into "winding," as the carpenter expresses it.

The width of the swing need not be more than equal to half the length of the camera base, and the length should be worked out according to the focus of the lens to be used, to enable reductions to be made at least a quarter the size of the original. The table has been already given, showing distance of original to ground-glass when copying to different scales, and will show the length of swing required.

The camera may simply slide on the rails, parallelism being attained by guiding battens fixed under its base; or it can be supported on a carriage travelling freely on friction runners, such as are put in window sashes, or, better still, iron rails with grooved wheels can be provided. It is also an advantage to have a rack and pinion motion to move the carriage along the base. The top of the carriage should have stops at each corner, with an opening between them equal to the width of the camera bed, so that the camera may be lifted off and placed at right angles to its former position, as is requisite in making reversed negatives. A more convenient arrangement is to have a turntable.

The copying-board is fixed on a sort of easel standing on the rails of the base frame. Whether the easel should be fixed at the end or slide towards the camera is a matter of choice. Sometimes a better light can be thrown on the board if it can be shifted forward, when

copying at close quarters, and, moreover, it is then not necessary to bring the camera forward into the full glare of the studio light.

In working with electric light I think it is best to have a fixed copying easel, as the light can be kept more uniform. The copying-board must run in grooves, so as to be capable of being shifted sideways. It should be possible to project it out beyond the base frame, because when copying with the mirror box or prism in position the latter is not central to the base frame, and the copying-board must be pushed forward to strike a centre to the lens. The copying-board should be of soft wood, so that it is easy to stick pins into it.

A good plan is to cover the board with a thin layer of cork, in which the pins can be inserted without any trouble, and there is no unevenness as when the board becomes full of holes. The copy-board will stand changes of temperature better if it is battened like an engineer's drawing board, not clamped.

A very practical way of overcoming the difficulties due to shrinkage and warping is to make up the board with narrow planks, not more than six inches wide, each with separate battens, and not tongued and grooved together. In this way each board shrinks or swells separately, and a clamping screw arrangement can be provided at the side for the purpose of squeezing the boards together when the joined edges open.

The size of the board should be at least four times the area of the largest plate the camera will take; in other words, its diagonal should be twice the diagonal

of a 15 x 12 plate if the camera is for that size. As a rule the boards in use are fully four times the diagonal of the plate size.

A rising and falling movement for the copy-board is not necessary. A horizontal line coincident with the centre of the lens should be struck across the board and the copy pinned centrally on this line. The copy-board should be painted dead black, as it then gives no reflected light, and is not so confusing to the eye when focussing.

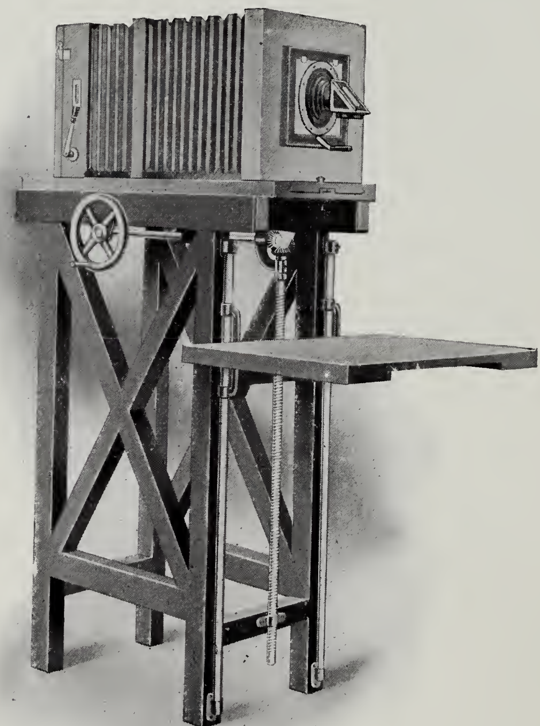


Fig. 23.

A form of stand which has some advantages is shown in fig. 23. It can only be used when the lens is fitted with mirror or prism, and the lens must be of comparatively short focus, or the stand will have to be so tall as to be inconvenient. Such a stand

takes up little room, and the downward illumination of the copy is very perfect, copying being done very well against an ordinary window.

It is very useful in copying from open books, or for making negatives direct from such objects as coins, medals, jewellery, etc. The direct vertical light obviates all trouble due to grain or surface reflections, and shadows may be avoided by having a glass plate for supporting such objects as jewellery, a white reflector being placed underneath at a suitable angle.

Next we must decide on the lens, and the essential points to remember are that it must be of the rapid rectilinear type, achromatic, of good covering power at a large aperture, and of fairly long focus. Single landscape lenses, portrait lenses, hand camera lenses, and wide angle lenses must be set aside as unsuitable. It will not be found practicable to use any lens under nine inches focus for the reasons subsequently explained, and even with that length it should not be used for anything larger than half-plate, $6\frac{1}{2} \times 4\frac{3}{4}$ inches.

It was formerly considered that extreme sharpness of definition was less important in a lens for the half-tone process than in one used for line reproduction, but whilst this may be true to the extent that want of sharpness does not show its effects so readily in half-tone as in line work, it will, nevertheless, be found that a lens which will give perfect definition will be a good one in all other respects. There will be times when its powers will be tested to the utmost, and it is only then that the operator appreciates the disadvantage of a poor lens.

Before proceeding to consider the various types of lenses on the market, it will be well to explain the reason why lenses for half-tone should be of long focus. It arises from the now well established rule that the distance of the screen from the sensitive plate is directly proportional to the focus of the lens if the diaphragm aperture remains constant; that is to say, the longer the focus the greater the screen distance. Therefore, if we diminish the focus more and more, we should get to a point where we could not operate the screen at all, for the simple reason that we could not have any space for the corner plates or wires which hold it in position, and to work it at all it would have to be in absolute contact. This would be an impossible condition in the case of wet plate work.

It is true that we may decrease the size of the diaphragm to enable greater screen distance to be worked, but this means increase of exposure; therefore, we are driven to the practical conclusion that to avoid the necessity of working the screen too close to the plate it is best to use lenses of fairly long focus.

It also follows that a long focus lens will have a narrow angle, so that the rays strike through the screen not far from perpendicular to its surface. A short focus lens of wide angle sends the marginal rays through the screen at a considerable angle from the axis of the lens, so that they have a longer path of glass to travel through, and are refracted more than the central rays, besides passing through the opening obliquely

and tending to form blurred oval-shaped dots. Again, a wide angle lens is generally a slow one, and for that reason is unsuitable. It also gives rise to a lot of reflections from the sides of the camera, which are apt to cause foggy plates. Still another reason is that wide angle lenses do not work well with prisms, as they pick up reflections and secondary images from the surfaces of the prism.

Of late years numerous lens makers have brought out lenses specially designed for process reproduction, and the most notable of these is the Cooke Process lens, which has experienced a wonderful degree of popularity. Its peculiar advantage is its great flatness of field, covering the plate to the extreme edges with remarkable definition, even at full aperture. It is a rapid lens working up to f/8, and of moderately long focus—18½ inches for 15 x 12 plate. Further, it is well corrected for astigmatism and achromatism, and its elements are simple, there being three separate lenses, with no cemented combinations. Another advantage is that the system of interchangeable screw fittings introduced by its makers, render it readily adaptable for fitting prisms, colour cells, etc., and for changing lenses from one camera to another, or from a smaller to a larger size. The price is also reasonable compared with some other modern types of lenses. The only drawback—if it can be described as such—is that it requires more care to ensure parallelism of copy, camera front, and sensitive plate, and also somewhat more care in focussing than lenses with more

rounded field. It should not be focussed for the centre of the plate, but for a general sharpness all over.

Ross' Symmetric Anastigmat and Dallmeyer's Stigmatic are two modern types of lenses which have improved upon and superseded the rapid symmetrical and rapid rectilinear lenses of the same makers, which for a long time enjoyed great popularity, and which are to be found, even yet, doing good work in many studios.

On the Continent Steinheil's Rapid Aplanat, Series VI., was formerly in great preference, but it has now been entirely superseded by the Orthostigmat, Series II., introduced by the same firm, and which is an excellent lens.

Voigtlander's Collinear is also a very good lens for half-tone work, Series III. being the best to use. More recently the same firm have brought out the Apochromatic Collinear lens with the special object of fulfilling the requirements of half-tone and three-colour work, and this lens has been very favourably reported upon.

The Goerz lenses are also admirably suited for process work, and of the two types the writer prefers Series IV., on account of its longer focus.

Of the Zeiss lenses several types are suitable. First and foremost is the Planar, which is in many respects a marvellous lens, on account of its high correction and wonderful covering power at large apertures, but its price places it almost beyond the reach of all but the wealthiest firms. The Protar is a good series of lenses for all practical purposes, and quite reasonable in price. They do not work at a larger aperture than 1:18

(corresponding to about f/16 according to the English standard), but they have very fine covering power, and the focus is long enough. They are well corrected for colour work. Series Ia., IIIa., and VIIa., and a new type, the Tessar, are also suitable for half-tone.

Apart from these well-known makes of lenses, it may be said that any good rapid rectilinear lens will serve if it fulfils the condition as to length of focus.

One condition should be insisted upon, whatever lens is chosen, viz., that it must have a slot for taking the Waterhouse shape of diaphragm, because, as we shall presently show, it is necessary to insert irregular forms of stops, and to change them sometimes during exposure. This could not be conveniently done if the lens had an iris diaphragm. In such case it will be best to have a new tube made for the lens, or, if practicable, a slot in addition, and in front of the iris diaphragm. The Cooke Process lens has this feature in all cases, and the Zeiss lenses are thus provided if specially ordered. This is very convenient, as both systems may be used.

Lens makers who cater specially for the requirements of process workers supply, when required, sets of diaphragms with suitably shaped apertures other than round ones. The use of these stops will be explained in a later chapter, and it will be sufficient to say here that a set of square apertures, at least, graduated in size, is a great convenience and an aid to uniformity of work. The Penrose Diaphragm System, which is supplied with all Cooke Process

lenses, and can be fitted to any other lenses, consists of a set of stops with square apertures, or square apertures with extended corners to promote joining-up of the dots. The apertures are graduated on a definite system, having an exposure ratio to each other of $1:1\frac{1}{2}$, *i.e.*, if a given aperture requires an exposure of one minute, the next size smaller requires $1\frac{1}{2}$ minutes. A book of tables supplied with them shows the screen distances for a given size of stop and screen, at any particular extension of the camera.

Any camera for making negatives for process work should be fitted with a mirror box or prism. The mirror plate fits in a triangular box (fig. 24), having one side set at an angle of 45° to the front of the camera. The lens is fixed on the side of the box, which is at right angles to the front, so that when the camera is placed sideways to the object, the lens pointing towards the latter, the image is transmitted through the lens, reversed as all lens images are, but the mirror catches the reversed picture and reflects it to the sensitive plate the correct way, *i.e.*, the same as we would look at the original. When the resulting negative is laid film down in contact with a zinc plate the image is again transferred reversed, but when the

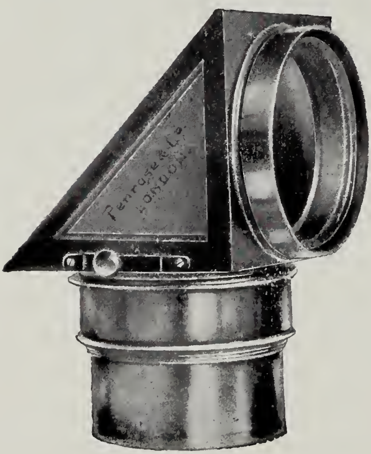


Fig. 24.

printer subsequently lays a piece of paper on the inked plate, and takes off an impression, the picture comes the right way again. I make this simple explanation, because it is often very difficult to make people understand the necessity for a reversed negative, though if they ever attempt to make a print directly on metal from an unreversed negative of some lettering, they will be taught completely the necessity for it.

On the relative advantages of mirror or prism, I may point out that it largely resolves itself into a question of first cost. A prism for 15 x 12 lens will cost from £8 to £16, according to the diameter of the lens and the reputation of the firm it is bought from, this price including the fitting in a brass or aluminium box, which is usually screwed on to the front of the lens, as shown in fig. 25.

Scientifically speaking the hypotenuse of a right angle prism should be a perfect reflecting surface, and theoretically it is held that it requires no silvering. This, however, does not work out in practice, as an unsilvered prism gives a prismatic band down one side of the sensitive plate, and this comes out a dark streak on the negative. When the prism is silvered this trouble entirely disappears. The reason of this need not be entered into here. Suffice it to say that all prisms in practical use are silvered, and once silvered they rarely need doing again. Thus, the great advantage that can be claimed for the prism is that it is a permanent reflector, whilst the mirror is very susceptible to tarnish, and constantly needs silvering, which

is too delicate an operation to be done at home. It is contended that a prism is slower than a mirror because there is a loss of light by absorption in the thickness of the glass and by reflection at its surfaces, but when it is remembered that a mirror can never be maintained in sufficiently good condition to make this comparison possible such a contention can have little weight. Certainly the prism is, to my mind, the best possible thing to use if the worker can afford it, and it is especially convenient in the colonies, or elsewhere abroad where the means of getting mirrors resilvered are not ready to hand.

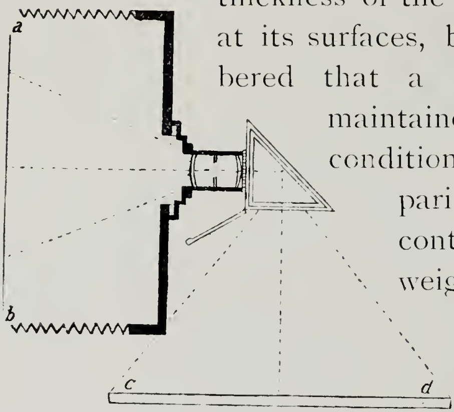


Fig. 25.
Illustrating position of prism—*a b* sensitive plate. *c d* copy-board.

An optical plane mirror costs about one shilling per square inch. This article is a piece of the finest plate glass, about $\frac{3}{16}$ths of an inch thick, ground down on one side until it is optically flat. It is then silvered on the surface—*i.e.*, the side which has been optically worked—not on the back of the plate, as in the case of an ordinary household mirror. The reason of this is obvious, for if you try to photograph a reflection in an ordinary mirror a double image will result, one reflected from the surface of the glass, and the other from the silvering at the back.

An optical mirror must be very carefully used or

it will soon become tarnished and scratched, and must then be resilvered; this resilvering, which costs about one-fourth the price of the mirror, will form a serious item of expense, if it has to be done often, and will involve stoppage of work for two or three days, unless one has another mirror to go on with. But if due care is exercised a mirror surface should last a long time.*

The mirror should be carefully put away, when not in use, in a case which is air, dust, and damp proof. If the surface becomes a little tarnished get some finest jeweller's rouge, well dried by spreading it out on a sheet of paper on top of a stove, and well rubbed to powder. Now take a tuft of cotton, also warmed to dryness, and rub it in the rouge, then upon a sheet of clean glass, so as to smooth down any grittiness of the powder, finally applying it to the mirror with a gentle circular motion, and patiently rub until the tarnish is worn off.

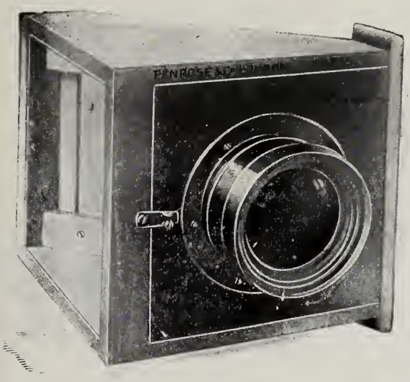


Fig. 26.

Mirrors are usually made from 4 x 3 inches up to 8 x 5, and 7 x 4 is an average size which will suit any lens up to three inches diameter. The rule is that they should be about one inch larger than the diameter of the lens one way, and also about one inch more than twice the diameter the other way. Two

* Metallic mirrors have recently been introduced which require no silvering.

should be purchased, so that one may be in use whilst the other is being silvered.

A focussing eyepiece of moderate power for the ordinary focussing of the image is required, and also a high power one which will enable the screen effect to be seen readily. Penrose and Co. make a little microscope for the latter purpose called "The Midget" (fig. 27). On the Continent there are several of these small microscopes on the market, notably "The Vagus." Steinheil and Zeiss also make instruments of this kind. These high powers are quite objectionable for ordinary focussing, as they magnify the grain of the image and the grain of the ground glass to such an extent as to mislead the operator.

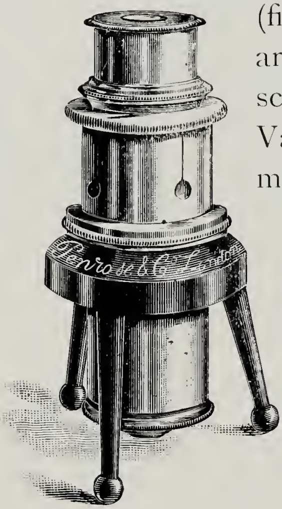


Fig. 27.

The remaining requirements are a large focussing cloth of soft, opaque black material, and a rule for measuring the size of image. Transparent celluloid rules are good for this purpose, as the image can be seen through them. A box of drawing pins should also be provided for fixing the copy on the board. These should have a large head, and be capable of being easily pulled out.

Unmounted prints, cuttings from books and newspapers, and pieces of fabric, are best placed in a light box pattern printing frame with plate glass front, which

is hung in front of the copy-board. This keeps the copies flat, and the photographing through glass is no detriment, provided the lighting is arranged so that there are no surface reflections.

The only other articles needed for the equipment of the studio are the ruled screens, and the importance of these essential parts of a half-tone outfit is sufficient to warrant a special chapter.

CHAPTER IV.

THE DARK ROOM.

MUCH of the success of half-tone work depends on having a properly appointed dark room. It will not do to set apart some stuffy little cupboard-like room for the purpose, nor is it advisable that it should be in a room separated from the studio by any distance. A comparatively large and well-ventilated room, with its entrance situated preferably at that point of the studio nearest to the back of the camera, is required. About half the floor space allotted to the camera will be a good size. Thus, for working 15 x 12 plates, 9ft. to 10ft. x 6ft. will be the dimensions, and this makes a very comfortable dark room, but if it is possible to get a room 10ft. x 10ft. so much the better. The sink and bench at right angles to it for filling the dark slide will take away about 3ft. in either direction, so that this leaves the room none too large.

Instead of a door some operators prefer a curtain, but it is apt to harbour dust unless shaken into the open air frequently. A sliding door is a better arrangement than a hinged door.

The best arrangement of all is, perhaps, a lobby

with inner and outer door, so that one may be shut before the other is opened. Where several dark rooms adjoin, a long passage could connect the whole, and so ensure the entrance to each room being in the shade.

The ventilation of the dark room is a more important matter than most people appear to think. Not only does a perfectly ventilated dark room add to the comfort of the operator, but it also contributes in a larger measure to the success of the delicate processes worked therein. Work done in a properly-ventilated room maintained at an even temperature will be much more uniform than it would be otherwise.

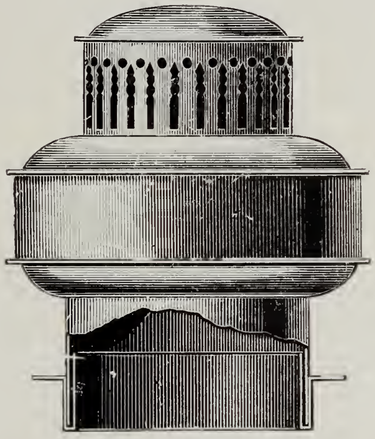


Fig 28.

Ventilators of the form shown in fig. 28 can be purchased ready made in sheet iron with any desired length of piping, and furnish a cheap means of ventilating a dark room.

An electric fan is a luxury, but, nevertheless, an excellent thing for keeping the dark room cool.

It must be borne in mind that wherever there is a ventilating outlet there must be at some other point an inlet for fresh air, and the most convenient way of arranging this is to provide it in the lower part of the door by having a few holes bored through, and

an inner panel arranged so as to cover up the light coming through them without obstructing the passage of air.

A Louvre ventilator—which is something like a Venetian blind—over the top of the door or window (if there is one) is a good arrangement for ventilation, where the cowl-shaped ventilator cannot be used.

A few holes or slots cut in the partition near the ceiling, and covered with some skirting to cut off any stray light, is a more rough-and-ready means of ventilating, which is used more often than not.

The walls and ceiling or woodwork should be black, or of some dark shade which will not reflect stray light.

Another matter to which attention must be paid in building a dark room is in regard to the prevention of dust, which occasions great difficulty in some processes. An effective way of minimising it is to cover all ventilating apertures with something like cheese-cloth or book muslin or gauze, in double thickness. Also the walls and ceiling should be covered with varnished or painted matchboarding, or papered with a smooth glazed or varnished paper, and the benches covered with lead or zinc, so that they may be sponged down occasionally. The floor should be laid with linoleum, which should be washed at least once a week and damped and swept daily.

At times when dust is very troublesome the air may be sprayed with an aspirator before commencing work.

It is very important to maintain an even temperature in the dark room, and it will contribute greatly towards uniformity of work if the temperature can be maintained at about 60°F. all the year round.

In the winter time some way of warming the dark room is requisite, and, of course, there must be no illumination from the source of heat. It is undesirable in any case that there should be a naked flame in the dark room, especially near the floor, as inflammable vapours, like ether and benzole, have a way of "creeping" along the floor and becoming ignited at a stove or fireplace.

Fletcher, Russell and Co. make enclosed gas stoves specially suitable for photographers' dark rooms, and there are also numerous excellent little oil stoves on the market which are as good as anything for the purpose. A hot water pipe, or a stove pipe, passing through the room will often serve, but will have the disadvantage of not being controllable.

Perhaps the ideal form of heating arrangement for the dark room is an electric radiator, which may be in the form of a hot plate, so that it can be used to warm up dishes or solutions. A good substitute for an electric radiator, which will cost nothing to run, and which may be readily installed, is the arc lamp resistance, which could be placed in the dark room and serve a double purpose, a good deal of heat being given off by some resistances.

A drying cupboard is also an arrangement which will serve the two purposes of drying negatives and keeping

the room warm. An oil-stove, or very small gas jet in a metal tube, will furnish the heat required.

Fig. 29 shows a suitable form of drying cupboard with wooden body, but having a sheet iron bottom in the form of an inverted shallow box, with holes punched all round, so as to allow sufficient air to mix with the gas to prevent the stove burner being "choked." The heat accumulates in this inverted box, and the bottom of the cupboard is thus warmed very evenly. It will be even better if the bottom is covered with a half inch layer of sand. The wooden sides of the box near the bottom are perforated with holes through which the cold air is drawn and rises with the heated air in the box until it reaches the top and passes out of the ventilator. An ordinary plate-rack can stand in the box to hold the negatives.

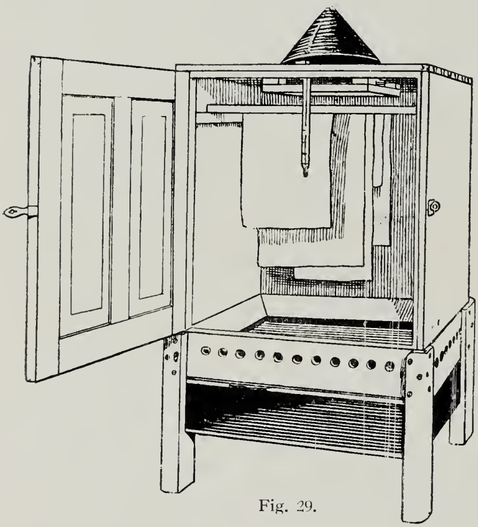


Fig. 29.

An ordinary cupboard for keeping light sensitive solutions, dry plates, or sundries in is also a very useful accessory, and tends to keep the room tidy.

The sink is the most important fixture in the dark room, and it is well worth going to some trouble and expense to get a really good arrangement in this way.

The author does not believe in lead-lined sinks unless made of very thick lead, and having burnt—not soldered—joints, which makes them expensive.

The safest and cheapest sink is one of Doulton ware. Get the deepest, which will be $4\frac{1}{2}$ inches inside. A very good size is the 36 x 22 inch, which is a stock article. Larger sizes may have to be made to order.

This sink should be supported on brick piers, or heavy iron brackets, though in many cases a wooden stand is made to serve the purpose, and, if possible, the waste pipe should be constructed of Doulton's enamelled stoneware tubes, which can be had with a stoneware trap and any kind of bend and connections. These are very reasonable in price, and if the joints are caulked and pitched a waste pipe will be obtained which will stand anything, and last practically for ever. On the other hand, a lead pipe will be a constant source of trouble owing to being eaten away by the chemicals put down. The acetic acid used in wet plate development is a very vigorous lead destroyer.

The water supply of the dark room is a very important consideration. Even when there is a supposed continuous supply from the mains it is better to have a large cistern overhead, as a failure of the water supply would mean total cessation of work.

Around the sink should be built slate draining-slabs, or wooden boards. These may be on a higher level, and the sink joined up to them with a skirting resting on the top of it. If wood is used a sheet of lead laid over the whole, with an opening the size of

the sink, and beaten to fit over the inside sides of the latter, gives the equivalent of a deeper sink and prevents splashing. The draining-boards should slope slightly towards the sink, and the latter with its draining-boards should occupy the whole of one of the longest sides of the room.

A good swinging arm spray tap should be fixed, the form of this piece of apparatus being such that the act of bringing it into position over the centre of the sink starts the flow of water. It is a convenience to have also an ordinary tap for filling bottles, etc. This tap should be high enough up to get a Winchester bottle, with funnel, under it. The spray should likewise be high enough up to get a negative or dish easily under it, without chance of bringing the film into contact with it, yet not so high up as to splash all over the place. A rubber collar or a piece of rubber sheeting wired round the spray nozzle will lead the water down to the negative, and be some safeguard against undue splashing.

A little wooden stool should be provided to rest plates and dishes on whilst developing or washing. A wooden grid in the bottom of the sink saves many breakages of glass ware.

Underneath the sink may be a rack for dishes. The soaking trough for old negatives and glass polishing bench is best arranged for outside the dark room.

The illumination of the dark room is an important matter. A window for daylight illumination is not a very desirable arrangement even for day work, because if it is made "safe" enough for working when strong

sunshine is upon it there will not be light enough in dull weather. The reverse case would be equally a source of trouble. Even though it were possible to make the light safe for all times it must be remembered that the daylight is varying from hour to hour, and as the operator must judge his negatives by looking through them towards the source of light, it would never be possible to secure any sufficient uniformity of work.

There is no objection to having a window which is made "safe" for all degrees of illumination for the general lighting of the room, so as to avoid burning gas or electric light all day long, and giving just sufficient light to avoid having to grope about to find things, but we must also have at the back, or at one side of the sink, a lantern for development and examination of negatives. This must be capable of furnishing both white and non-actinic light, which can be secured by having two or more glass fronts to it. One may be white opal or ground glass and the other amber or ruby, according to whether we are working wet or dry plates. Perhaps the best arrangement for all purposes is to have the lantern with a permanent front of white glass and two folding or sliding fronts containing amber and ruby, which can be used alternatively or together. If used for electric light this lantern may be constructed of wood, but for gas it must be of sheet metal and very large, with plenty of ventilation, or it will get hot and the glass fronts will be continually breaking. The same thing applies, though in a less degree, to oil lamps.

The position of the lantern should be at the back of the sink, either directly opposite, or at the side. In the latter case it should be placed diagonally across the corner. The front should slope over towards the sink, or the light should be reflected down by means of a hood.

Instead of using coloured glass, which is frequently unsafe, it is preferable to use the non-actinic fabric sold for the purpose of covering dark room windows, and to enclose it between two sheets of plain glass. This gives a more diffused illumination, which is pleasant to work by.

We must caution the inexperienced worker against being tempted to buy the so-called non-actinic electric incandescent lamps. They are certainly coloured ruby, but are as a rule quite unsafe. It seems to be an impossibility to make a safe electric lamp, probably owing to the fact that the glass-blower could never get the walls of the bulb the same thickness. The electric light being also rich in actinic rays is more penetrative through the coloured medium than is, say, gas or oil light.

Fig. 30.

A very effective compromise for the coloured glow lamp is that illustrated in fig. 30. The large bulb encloses an ordinary lamp, and being split the lower half is hinged so that it can be let down, and give white

light at will. The coloured glass of the outer bulb is thick and dense, and a certificate of its safety is given by the manufacturers. The lamps are supplied in amber and ruby.

For three-colour negative making, where it is very important to be able to have the illumination of such a colour as the plates will be insensitive to, it is desirable to have a separate small lantern of the kind shown in fig. 31, so that, if necessary, different screening glasses can be put in. Special fronts can be made up by coating glass with coloured collodion. What is called a "safe light" for three-colour work is made up of two and sometimes three glasses or films, and forms a very dense ruby shade. The exact colours and final combinations have to be determined by spectroscopic tests.

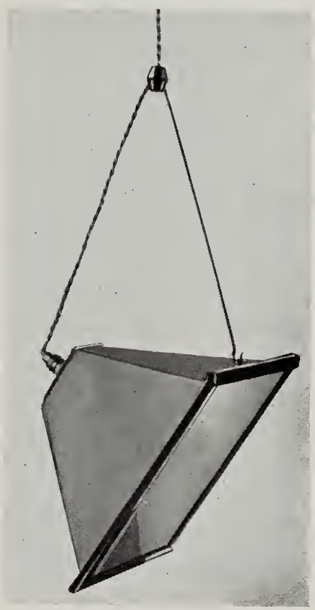


Fig 31.

A narrow bench down each side of the room is necessary, one side being kept clear for filling the dark slide, which should lean against the wall of the room when being filled. To avoid the dark slide slipping off the bench through being inclined at too great an angle, it is desirable to fasten a fillet of wood on the bench to stop the slide. A place should

be reserved, also alongside, for the lid of the slide, which, if put down on the floor underneath, is apt to get kicked, owing to the darkness, and thereby split or broken.

A drawer or two under the bench to contain dusters, polishing cloths and leathers, cotton wool, filter papers, and other things which should be kept dry and clean, is a convenience.

The position of the bath when the wet plate process is used should be as near as possible to the dark slide, and as far as possible from the developing sink, so as to obviate splashes of developing or other solutions finding their way into it. The position should be such, however, that a good light falls upon it, so that one can easily see to put the plate in and take it out. If a dipping bath is used, the mouth of it should be level, or thereabouts, with the bench.

Better still is the plan* of having a box for the bath as here illustrated (fig. 32). Such a box can be constructed of match-boarding, and should be about six feet high. In constructing a dark room it would, of course, be built into it, a recess probably suiting well for the purpose. The depth will be about twelve inches, whilst the width will be suited to the size of bath that is being used. For a 15 x 12 bath, eighteen inches would be a good width. About three feet from the floor is an opening the full width of the box and the same measurement in height, so as to leave a square opening. A sliding door to run up and down like a window sash, and

*Suggested by A. C. Austin in "Half-Tone and Tri Colour Engraving."

balanced with a weight, should be fitted to run in deep grooves that effectually shut out the light when the door is closed. At a convenient height from the floor is a shelf on which the bath rests, with its bottom edge pushed against the front of the box, and its back resting against a rail about five inches away from the

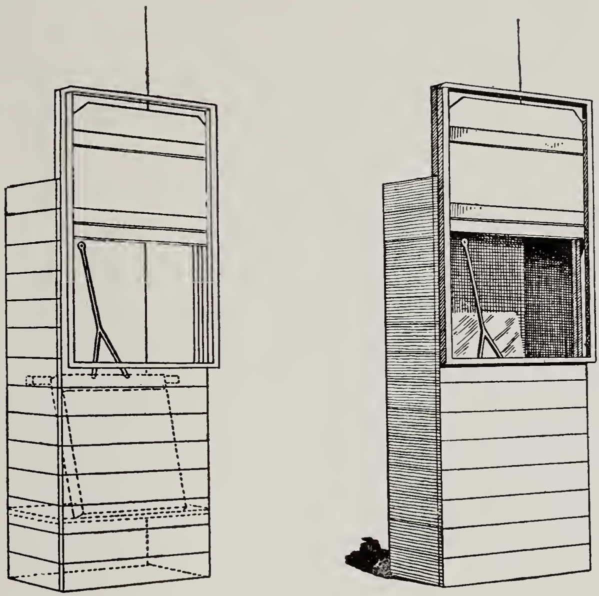


Fig. 32.

back of the box. An improvement would be to have a dish or tray the size of the bottom of the shelf, which would catch all stray drainings when removing the plate. The dipper is provided with a hole in it near the top, so that it can be hung up on a nail, whilst its lower end remains just inside the mouth of the bath. In this way the dipper can be hung up with the

plate left on it to drain, whilst the operator is performing other operations; or an assistant can always have a plate ready for the next exposure. If there is any difficulty in lighting the interior of the box it can have a coloured window in the side or in the top, if it does not extend to the full height of the room, supplied with an incandescent lamp to illuminate it. The lamp previously illustrated (fig. 30 *ante*) could be hung inside from the top of the box, and would suit admirably without any alterations.

In the winter time a spirit lamp may be placed on the shelf beside the holder in order to keep the box at an uniform temperature, whilst in excessively hot weather a dish of ice will keep all cool.

The blackening of negatives with ammonium hydrosulphuret should not be done in the dark room, as the fumes are liable to upset the working of the bath. The best plan is to have a sink fitted up outside a window, enclosed with glass, something like the window cases for ferns and plants, but with some opening or perforations to allow the fumes to escape freely into the open air. If this cannot be arranged a fume chamber, such as may be seen in any chemical laboratory, should be erected.

In case any reader may never have seen such a thing, it may be understood as very similar to the bath box just described, in fact the same pattern would do with a little modification. The sliding sash has usually a glass pane in it. The shelf is on a level with the bottom of the opening, and is lead covered. It is all

the better for our purpose if there is a small sink with water supply and waste pipe in the box. At the top there must be a ventilator leading to the open air, or into a chimney, and a small gas jet should be burned high up in order to cause an upward draught. Of course, all joints and crevices must be carefully stopped up.

The dark room outfit is comparatively simple. If the wet collodion process be worked, as it undoubtedly

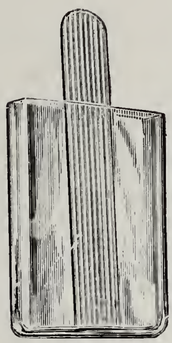


Fig. 33

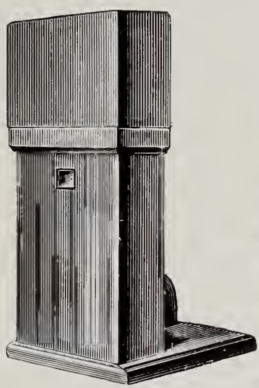


Fig. 34.

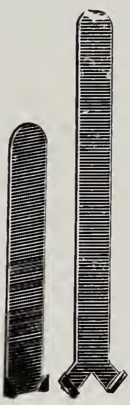


Fig. 35.

will be for commercial work, a dipping bath (fig. 33) will be required, and the only point to pay attention to in selecting this is to avoid porcelain baths or heavy green glass baths. Also the author does not recommend ebonite or guttapercha baths. The best thing is a white glass bath with parallel sides. They are perfectly transparent, and thus it can be readily seen when the bath is clean. A well made wooden case with lid should be provided for the bath (fig. 34).

For a dipper to support the plate when immersing it in the bath, a white glass one is the most reliable, and though it may be liable to breakage, it is very cheap. An ebonite dipper (fig 35) is not so liable to breakage although it is rather brittle, but one can never tell what action it may have on the bath, and it is not easy to determine when it is clean. In case of à breakage of a dipper one may be made of wood soaked in paraffin wax, but it is not advisable to use this for long. A dipper of pure silver would be an excellent but very expensive arrangement.

Although the author recommends a dipping bath as the best security for keeping the bath solution in good order, he does not ignore the fact that many practical workers are daily using, and prefer, simply a horizontal dish. This may be the ordinary porcelain deep dish, or one of the deep glass dishes which are sold for the purpose. Very large trays are of ebonite, guttapercha, papier-maché, or wood, the latter being thickly coated with some protective varnish. A mixture suggested for this purpose consists of bitumen and beeswax. Wooden trays with glass bottoms are sometimes met with, but it is not easy to get them free from leakage.

The advantages claimed for the horizontal bath tray are that it requires less solution, and that by exposing a larger surface to evaporation the alcohol and ether which the bath takes up from the plate have a better chance of escaping. There is, however, more risk of the bath becoming contaminated with foreign matter.

If the horizontal bath is used, it should be provided

with a loosely fitting cover in the shape of an inverted box, which rests on the rim of the dish without touching the shelf or bench, as it would in the latter case pick up dirt which might get into the bath.

For this form of bath, plate lifters of silver wire or ebonite are used (fig 36).

The horizontal bath should be provided with a rocker, which may be simply a piece of wood about one and a half inches in height, screwed on to the bench. The tray should be three or four inches larger than the plate, so that the solution can all be tipped to one end, allowing the plate to be placed in "high and dry." The solution can then be rocked over the plate in one even wave, and kept in motion, flowing to and fro.

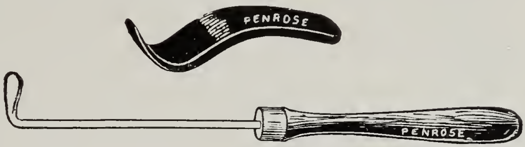


Fig. 36.

Most of the operations of wet plate development being done by pouring the solution on to the plate whilst held in the hand, dishes are hardly necessary, but two should be provided for intensification—one for the bleaching solution and one for the blackening. These may be the size of the largest plate worked, and of the deep kind.

A set of graduates, comprising 40 oz., 20 oz., 16 oz., 10 oz., 8 oz., 4 oz., 2 oz., 1 oz., and 60 minims is a necessary part of an outfit. Likewise scales and weights from ½ grain up to 1 lb. Two sets will be required—grain scales weighing from ½ grain up to 2 drams, and pound scales weighing from ¼ oz. to 1 lb.

An argentometer (fig. 37) is a necessary part of a wet plate outfit. By its means the number of grains of silver in each ounce of bath solution is determined.


Fig. 37.

As the bath gets weaker by use, it may be tested by this instrument and fresh silver added to bring it up to strength again. The continental argentometer registers percentage of silver in the solution instead of the number of grains per ounce, and this is more accurate. When purchasing one of these instruments it should be ascertained which method of reading is adopted.

A pneumatic plateholder (fig. 38), which attaches itself to the plate by suction, is a useful article. It should be of solid red rubber, as this form is most durable and powerful. For larger plates various contrivances are used for supporting the plate. The simplest, and probably the most effective, is a stone jar with an indiarubber ball in the mouth of it, the ball being chosen too large to be pressed in. The plate can be rested on this and swivelled about in any direction. One of these arrangements can stand in the sink for developing and another on the bench for collodionising.


Fig. 38.

Several glass stirring rods will be useful. They should be thick, as it is then possible to use them for breaking up crystals. A small glass mortar and pestle is also very good for that purpose. A good porcelain mortar and pestle is in any case essential.

A few funnels are wanted. One large glass one,

about 10in. diameter, should be kept for the silver bath, and it should not be used for anything else. It is good to have one of every size, and keep each for its special purpose. They run up in size from 2in. to 10in., increasing by 1in. in diameter. For the intensifier it is best to use a papier-maché, ebonite, or guttapercha funnel, as it cannot be mistaken for any other purpose. A funnel stand is a cheap and useful accessory.

It is always better to let collodion settle rather than filter it, but if for want of time it must be filtered a funnel with the top edge ground flat, and a glass plate laid on in order to prevent evaporation is a good arrangement. One, perhaps better, but not having so large a capacity, is the old-fashioned collodion filter bottle (fig. 39). The bulb at the top is stoppered, and in the bottom of it is a neck ground to fit into the bottle. Inside this lower neck of the bulb is stuffed a tuft of cotton with a tube passing through and descending into the bottom vessel. This lets the air escape as it is driven out by the descending fluid, and helps the filtering. Of course, the tube must always be kept above the level of the liquid in both vessels.

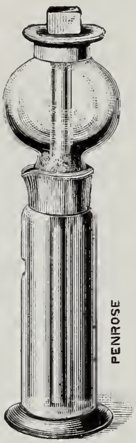


Fig. 39.

Fig. 40 is another form in which filter and pouring bottle are combined. The inner funnel descends nearly to the bottom, and a piece of muslin is tied over the end. All the liquid poured out must therefore pass through this filtering medium.

For keeping collodion in bulk, a glass bottle with tap near the bottom is the best arrangement. The collodion is then drawn off at all times free from sediment. The next best thing is to fit a syphon to an ordinary bottle.

Fig. 40.

A collodion pouring bottle (fig. 41) is a decided help towards securing clear negatives. It is sometimes known as a "cometless" collodion bottle, because of its alleged property of trapping the floating particles which produce the spots on negatives known as "comets." It is a tall glass bottle, a large cap covering the neck and protecting the pouring lip, so that dust cannot adhere and find its way to the plate. The inner neck descends about an inch into the bottle, so that when pouring only the liquid on the surface runs out, the sediment from the bottom of the bottle being caught by the projecting neck. There is a notch down the side of this neck so that any collodion running over finds its way back to the bottle. The tallness of this bottle assists the precipitation of any sediment in the collodion. A tall bottle of conical shape is also good for pouring collodion.

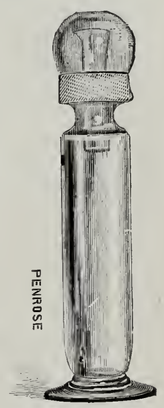


Fig. 41.

There are some handy developing cups of glass to be had. They nest within one another, and are sold in sets of three, large and small, and being of thick toughened glass they are very durable. These cups are good for pouring the developer on to the plate.

A gallon white glass bottle will be required for containing the bath solution when out of its trough for filtering or any other reason. This bottle should not be used for anything else. Being of white glass it is useful for sunning the bath. It is all the better if provided with a glass tap. (Fig. 42.)

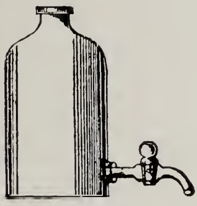


Fig. 42.

Three or four bottles are necessary. One for the developing solution, two for the intensifying solution, and one for general use. Don't keep a lot of unnecessary bottles in the dark room—they only make the place untidy, and render it more difficult to keep down the dust.

A couple of dropping bottles are useful for containing the iodine and the cyanide solution used for "cutting" the negatives, as described later on. The best form of dropping bottles are on the pipette principle.

Fletcher's autometric dropping bottle is excellent and cleanly for the purpose. The dropping tube is graduated, and therefore saves measuring. One of these bottles is useful for keeping a stock solution of silver nitrate for strengthening the bath, adding to the redeveloping solution, or to the silver solution used with the copper bromide intensifier.

For the purpose of boiling down the bath solution an evaporating basin and gas or spirit stove will be required, besides an iron tripod to support the basin over the stove. The naked flame must not be allowed to come into contact with the basin, or the latter may be cracked and a valuable lot of solution wasted. It is easy to avoid this by having a tin tray filled with sand, bedding the evaporating basin in this, and applying the heat to this "sand bath."

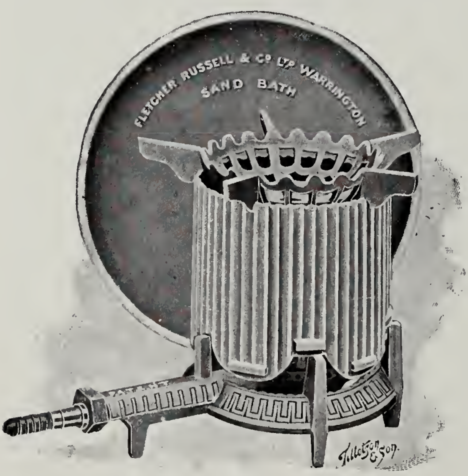


Fig. 43.

Fletcher, Russell and Co. make an excellent arrangement for the purpose, comprising stove, draught-guard, and iron tray for the sand bath. (Fig. 43.)

The evaporating basins may be either of porcelain or enamelled iron. There are two kinds of the latter, one being made of stamped steel, and the other

of cast iron. The latter is best for large sizes. One is apt to be suspicious of trusting a silver solution in an iron vessel, even when enamelled, but these basins are certainly in use in many of the largest establishments without any disadvantage being known. The porcelain basins are undoubtedly the most cleanly, and a careful worker will prefer them.

To determine when the bath has been boiled down to the right strength, it is a good plan to have a specific gravity bulb. This is graduated to float in a given strength of solution. The bulb is thrown in when the boiling commences, and when it comes to the surface and remains floating it is known that the operation is completed.

The specific gravity of a freshly made silver bath of

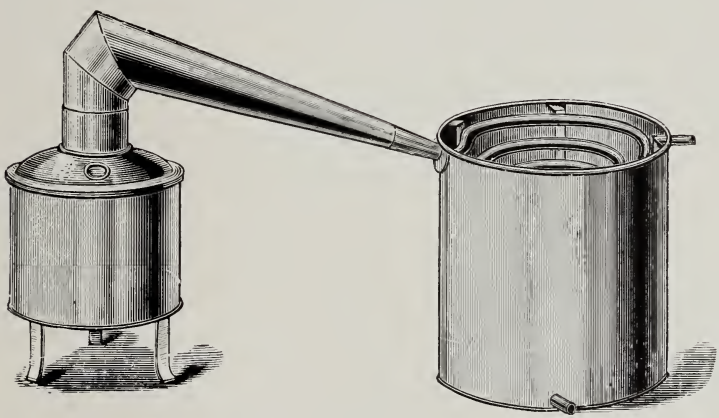


Fig. 44.

the correct strength, namely, thirty-five grains to the ounce, will be about 1·069, and when boiled down to half strength it will be 1·035, so that the latter is the figure the bulb should be chosen for.

In the colonies and in country districts where a supply of distilled water is not easily obtainable, a still will be found a good investment for obtaining a supply of pure water for the bath. There are several very cheap patterns on the market for the purpose, the orthodox form being as fig. 44.

A small laboratory Bunsen burner is a useful accessory in or near the dark room for rapidly drying off negatives, warming negatives for varnishing, warming solutions, etc.

A couple of plate racks, one for the clean glass and the other for finished negatives, are necessary, and most operators believe there has been nothing better invented than the old fashioned **V**-shape folding rack, but it should be of a substantial pattern. The **V**-shape made fixed (non-folding) is the best idea. For very large plates something more substantial is required, and the rack is generally provided with a heavy base, as fig. 45.

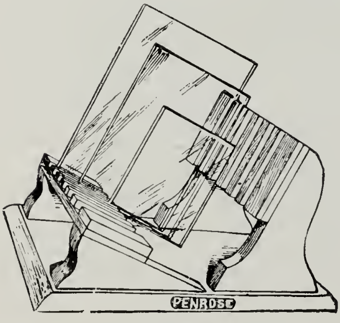


Fig. 45.

An outfit of negative glass will be required for wet plate work, and it is seldom worth while working any size below $8\frac{1}{2} \times 6\frac{1}{2}$ inches. Patent plate is undoubtedly the best to use, but it is expensive. If, however, it is carefully handled in the washing and cleaning operations it will last for a long time. There have been several cheap imitations of patent plate introduced of late, which, whilst not having the same planeness as

patent plate, are better than the ordinary negative glass. Flatted crown is next best, but often difficult to obtain, as the manufacture is restricted. The majority of commercial firms use a good sheet glass, sold by dealers specially for photographic work; this serves all practical purposes.

For cleaning the glass, a lead lined wooden trough with leaden grooves is the best thing, though expensive. It has the advantage that the plates do not get scratched and chipped, as they do in stoneware troughs, and therefore the glass has not to be so frequently renewed.

A polishing vice (fig. 46 for holding the glass plates whilst being cleaned is very useful, as it saves the chance of finger marks being left on the plates, which are, moreover, cleaned right up to the edges. A board covered with American cloth is often used for cleaning glass upon, but it has the disadvantage that the under side of the glass cannot be kept free

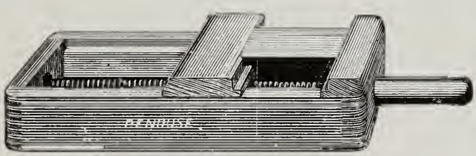


Fig. 46.

from the polishing paste or powder. To get over this difficulty a curved board has been introduced, so that the plate is supported on two edges.

A camel hair mop for dusting the plates before collodionising should be kept in a handy place in the dark room, either hung up, or provided with a projecting strip to prevent it touching the bench.

For applying the rubber edging to plates a camel hair brush is pushed through the cork of the bottle

of rubber solution, and on the side of the brush is fastened, by means of small rubber bands, a piece of wood such as the stalk of a large match, to act as a guide by rubbing against the edge of the plate whilst the brush is run round the margin.

If the dark room is used for collodion emulsion or gelatine dry plates some slight modification in the equipment will be necessary. We do not advocate working two or three processes together in one dark room—it is always best to have separate rooms, or at any rate separate sinks. For collodion emulsion work very little difference need be made in the arrangements except to have a separate set of utensils. For gelatine dry plates a set of dishes of all sizes, deep and shallow, will be required for developing, intensifying, etc. Of course, the lighting of the dark room must be arranged to suit the different sensitiveness of the plates.

CHAPTER V.

THE PRINTING ROOM.

IN using the word "printing" it must be understood that by this is meant the process of transferring the photographic image to the metal plate, and in the room described as "the printing room" are conducted all the operations appertaining to this part of the process. Perhaps a better term would be "exposing."

In many small workshops a portion of the dark room is set apart for this purpose, but it would be better to have a separate room, if space can be afforded, for, although printing is very often a duty that falls upon the photographic operator, it is best, even where one man does both things, to give him separate rooms, so that the appliances for one process do not get mixed up with those for the other.

A room about the same size as the dark room already described will be sufficient, though for preference it is better that it be larger, as more bench room is required.

It is desirable that besides the room for the preparation and development of the plates—analogous to the photographer's dark room—there should be what we may term a "light" room, that is to say, a room in

which the exposure is carried on, as well as such operations as "burning-in" the enamel, which requires a good light. In this room the arc lamp for printing will be placed. The cutting up and polishing of the metal plates previous to coating may also be done here, and, indeed, this is desirable, as polishing operations done in the dark room are likely to give rise to dust.

The exact arrangement of the printer's "light" room and dark room must depend a good deal on the shape and space allowed, but I will assume that these rooms are on the same floor as the studio and at the opposite end to the developing dark room. This will enable me to keep to the plan already sketched out, and will be a convenient arrangement, as it is always best to have the printing department near to the studio. The negatives can then be passed to and fro without delay, and the printer is constantly in touch with the photographic operators.

I will suppose it possible to have the " light " room leading out from the studio, and beyond this the dark room.

Starting with the "light" room first, it will be seen that there is first a guillotine for cutting up the metal. There should be a shelf or two behind for standing up pieces of cut metal, and a box for waste metal under the machine. This waste may soon amount to considerable value in an establishment where a good deal of work is done.

Next comes the polishing bench, for cleaning the

metal with pumice, emery, whitening, or such like materials, to free it from greasiness entirely. This will be practically dry polishing, only a little moisture being used. Where charcoal polishing is resorted to it should be done on a sloping board in a sink.

On the other side of the room is a bench for the printing frames. A shelf underneath should be provided for the empty frames not in use. They are brought up on the bench, and the screw bars, back, and pad laid out so that the negative and plate may be put in and screwed up. After exposure the frame is returned to the same bench in order to take the plate out.

The arc lamp is placed in the centre of the room, and is usually hung near the ground, so that the frames may be placed on the floor around it, and at a suitable inclination. The lamp is furnished with an umbrella-shaped reflector, which throws all the light downward.

Some printers prefer to have the lamp arranged to throw the light in a horizontal direction, with a reflector at the back, and the frames standing on edge on a bench. This naturally limits the number of frames that can be printed to one or two at most.

It is well in either case to have a hoist to raise and lower the lamp, so as to get the arc quite central whatever size of frame is being used.

The only other furnishing of the room is a small bench for the "burning-in" stove. It is best that this operation should be done outside the dark room, as it makes the latter very hot, and, moreover, it is easier to watch the progress of the burning-in.

A window at each side of this room is desirable, and outside these windows should be hung a tray on which to place printing frames for daylight exposure, unless the room is on a level with the ground, or with a roof-flat, in which case it will be better to have a door, so that the frames may be carried outside.

The corner where the frames are filled and emptied should not be in too strong a light, for although the coating is not very sensitive to momentary exposure to indoor light. there is a risk that it may be unduly acted upon. The corner could be screened off with a hinged window shutter frame covered with yellow fabric, or if the bench immediately inside the dark room is not required for any other purpose, the best way will be to fill and empty the frame there.

The exact way of utilising the bench room must depend on the processes worked. If the inking-up method with albumen bichromate as the sensitive coating is used for line work or coarse half-tone, as well as the enamel process, it will be necessary to provide space for the ink slab and the inking-up stone. This inking-up has to be done in a subdued light, and it should not be too near the sink, or splashes of water may sometimes spoil a print before it is inked.

Passing into the dark room—which, by the way, should be illuminated with a full yellow light, such as can be obtained by covering the window with yellow paper or fabric—the principal provision is a good sink and plenty of bench room. In some dark rooms one sink is made to do duty for whirling, developing, and a

variety of other purposes, but this is a mistake. There should be at least a separate sink, or, better still, a circular tub for whirling.

For the latter purpose there is nothing better than a half cask, *i.e.*, a cask sawn in half. Such tubs can be purchased as washing tubs at oil stores. The tub should be placed on a stool at a suitable height, and, if possible, connected up by means of a lead pipe to the waste. Over the tub can be suspended the whirler, whatever form it may be. If of the pneumatic suction or the clamp-board pattern it can be hung on a hook, whilst the Levy pattern can have its swinging arm permanently attached to the wall.

A swing arm tap, or a tap placed high up, and with a piece of rubber hose to it for swilling the plate, as is necessary in some methods of coating, is a desirable acquisition, especially as the hose can be utilised for washing out the tub and keeping it damp. The latter precaution will prevent the joints starting through dryness, and it will keep down the dust.

A gas stove, on a swinging arm, is also a useful feature, as it can be swung under the whirler to dry the plate whilst the whirling is proceeding.

A rack for the developing trays under the bench or sink, a drawer for cotton wool, and a shelf or two for bottles complete the equipment.

It is immaterial whether the sink is a lead-lined wooden one or an earthenware one. The latter is the most durable and cleanly. A stool should be provided to rest the developing dish upon, and the tap should

have a rubber hose. A spray is unnecessary and rather undesirable, as it may wash off a tender film. If whirling has to be done in the sink it must be fairly deep, or the operator and surroundings will receive the splashes.

For artificial lighting two or three incandescent lamps should be provided, and a gas bracket for emergencies. The same applies to the illumination of the "light" room in foggy weather and at night.

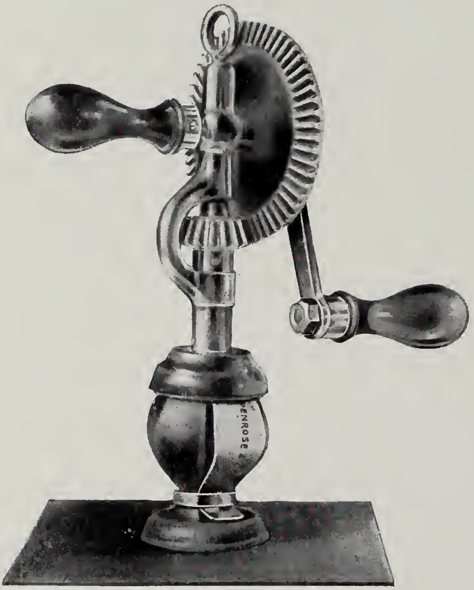


Fig. 47.

The first piece of apparatus to be considered in the printer's dark room is the whirler, which is used for forming an even coating of the sensitive solution on the metal plate. Many printers have got their own ideas about whirlers, and favour some particular makeshift of their own, but there are two or three patterns on the market which have become standardised.

The most popular is the pneumatic whirler, introduced by Penrose and Co. Fig. 47 shows the construction very clearly. The end attached to the plate is an indiarubber bulb with a mouth applying suction to the

plate. The whole apparatus is very light, and can easily be held in the hand whilst the whirling is done in the sink or the whirling tub, with the plate face downwards. In this way the splashes are retained in the sink, and dust is avoided owing to the damp surroundings. The whirling can be completed over a stove so as to dry the plate at the same time.

This whirler cannot be safely trusted for plates over 12 x 10 inches, but the same makers have recently introduced another whirler, extending the same principle, for larger plates. Instead of depending on the pressure of the bulb for creating the vacuum between the plate and the sucker, a small brass pump is provided, very similar to a bicycle pump. The sucker is much larger, and will carry a plate twenty inches square or over.

In some climates where rubber perishes very rapidly these forms of whirler are unsuitable, but the rubber may be replaced by a straight bar with two screw clamped clips sliding on it to hold the plate.

Another modification of this whirler is to use a "force cup," such as is used by plumbers for clearing drains and sinks. It is thought that this form of holder gives a better pneumatic grip on the plate, but actually it is inferior, as a larger volume of air has to be driven out before the vacuum is formed, and there is a considerable risk of leakage at the screwed joint.

It is also possible to have two springy pieces of wood arranged to form a clamp when pressed open, and the plate inserted between.

The Levy whirler, fig. 48, is a very good fixture for large plates. It is attached to the end of a swinging bracket, with the other end fixed to the wall. The whirling portion is pivoted on a horizontal axis, so that

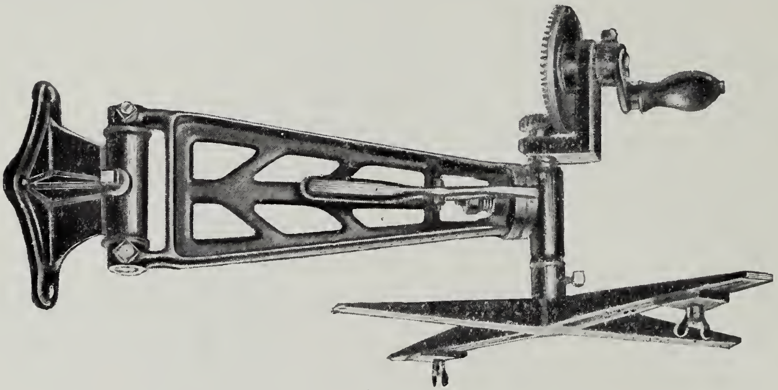


Fig. 48.

the plate can be face up for coating, and then turned face down for whirling. This form of whirler can be fixed over a tub, as already described, and the swinging arm permits it to be swung from the tub over a stove for drying off.

The turntable whirler (fig. 49) embodies a very good principle, but its disadvantages are that as the plate has to be whirled face upwards it is liable to attract dust; further, that unless there is a guard round it

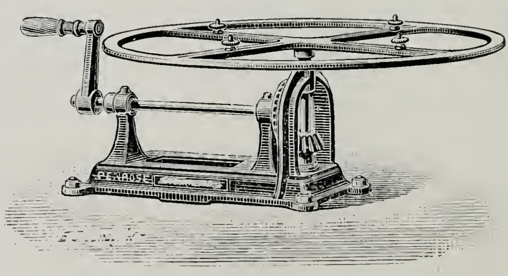


Fig. 49.

there is a great deal of splashing about the room and

upon the operator; also the plate cannot be quickly detached. Its chief advantage is for large and heavy plates, and for lithographic stones when the latter are used for direct half-tone printing. When fitted inside of a circular iron box with a trough round to catch the surplus solution, a small stove inside to dry the plate whilst being whirled, and a glass lid to keep out the dust, this form of whirler becomes very efficient, and the author has seen such whirlers capable of taking a plate up to forty inches square.

Most other whirlers in use are modifications of one or other of these principles, and need not be particularly described.

A gas stove of the ordinary circular pattern, but one that will give a good spreading flame, is required near the whirler for drying off the plates. The gas connection should have a tap for regulating the flame. If the fitting already exists without a tap, it will be possible to put a clip spring of some sort on the rubber tube to attain the same object.

Some printers prefer to place a plate of sheet iron over the stove to disperse the heat, instead of allowing the naked flame to play on the coated plate. This is undoubtedly a good idea, but the plate should be fully a quarter of an inch in thickness, or it will soon bend out of shape. It should be placed two or three inches above the flame.

For the preparation of the sensitive solution used by the printer, it is advisable to have an entirely separate set of utensils, as the fish glue, albumen, etc.,

is very "messy" and difficult to clean off if the vessels are required for other purposes.

A large basin, such as the household pudding basin, for mixing, is required, also one of the rotary egg whisks which are sold for household purposes. Although there are plenty of other ways of beating up albumen, this is perhaps the quickest and most effective.

The filtering is always a troublesome operation in the case of fish glue, and various devices have been adopted. The simplest but least effective way is to plug the neck of a funnel with wet cotton. This serves very well for the albumen bichromate solution for line work, but is not good for fish glue. If the latter is too tight the solution will not go through, if too slack the filtration will be imperfect. Paper is practically useless for fish glue.

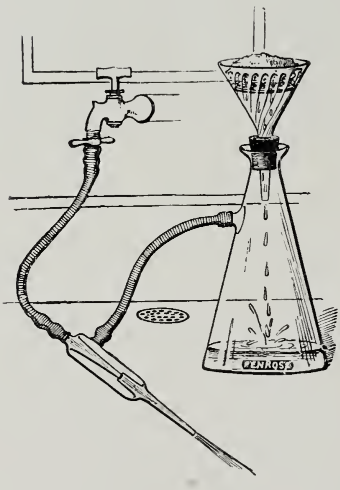


Fig. 50.

Glass wool does not trap the fine sediment sufficiently. Wash-leather soon gets tough and non-porous. Swansdown, muslin, cheese cloth, and such like materials have been tried without becoming popular. The author has found nothing better than coarse white flannel or felt, cut and folded like a filter paper. It must not be too thick nor too close in texture. After use the flannel should be thrown into a dish of

water, and when wanted again well wrung out. If allowed to get dry it soon becomes useless.

The most effective way of filtering, though it is slightly more troublesome, is to have a vacuum filter (fig. 50). The effect of the water rushing through the small glass pump is to draw all the air from the lower vessel, and the atmospheric pressure on the liquid in the funnel then drives it through the filtering medium, which may be, in this case, absorbent cotton. To prevent it being sucked into the neck of the funnel it is usual to have a perforated porcelain filter plate to support the cotton, this spreads the cotton out to give a larger filtering surface.

When filtered, the glue should be transferred to a wide-mouthed bottle. No cork or glass stopper should be used, as it would become cemented tight into the neck. A piece of cardboard or glass laid over the mouth to keep the dust out is all that is required.

For pouring the solution a lipped beaker or wide-mouthed measure is better than a bottle. A collodion pouring bottle would be excellent were it not for the glue cementing up the neck and rendering it impossible to remove the cap or pouring neck.

A few measures, bottles, stirring rods, a mortar and pestle, and at least three dishes will complete the outfit for the printer so far as his dark room is concerned. One of the dishes is used for water developing, another for the dye solution, and another for methylated spirit used in drying.

In the printer's " light " room the printing frames are

the first consideration. There have been innumerable attempts to improve on the screw pressure printing frames originally adopted by process workers, but the fact remains that to-day, as ten years or more ago, the frame with the greatest number of screws at the back is the most popular. The screws were formerly of beech-wood, threaded into beams of the same material, but of late years iron screws in iron bushes have been the most popular. A frame which has practically become a standard pattern is shown in fig. 51.

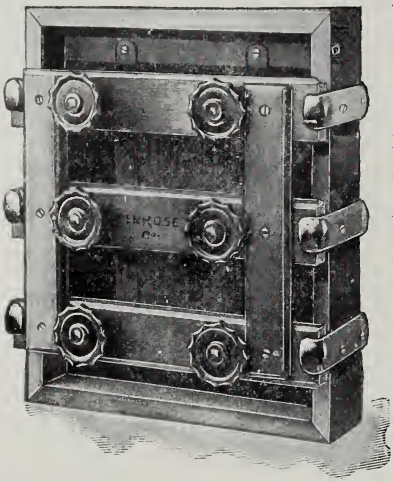


Fig. 51.

These frames are very heavy and strongly constructed of oak, with iron clamps at the side to take the thrust of the pressure. The boxes are always larger than the negative, the front being fitted with thick plate glass, against which a negative of any size smaller than the box may be laid. The frames are made in various sizes, generally one inch larger each way than the standard photographic sizes. The plate glass front varies in thickness from half an inch in the smallest to one and a quarter inches thickness in the largest sizes. The number of frames necessary is dependent on the quantity of work, and the speed with which it has to be turned out. At least two frames should be at hand, so

that whilst one is being exposed another is being got ready. It is useful to have one or two small size frames as well as those the full size of the largest plate the camera will make, as the little frames are quicker and easier to handle.

Amongst other styles of frames which have been recommended from time to time is one with the pressure

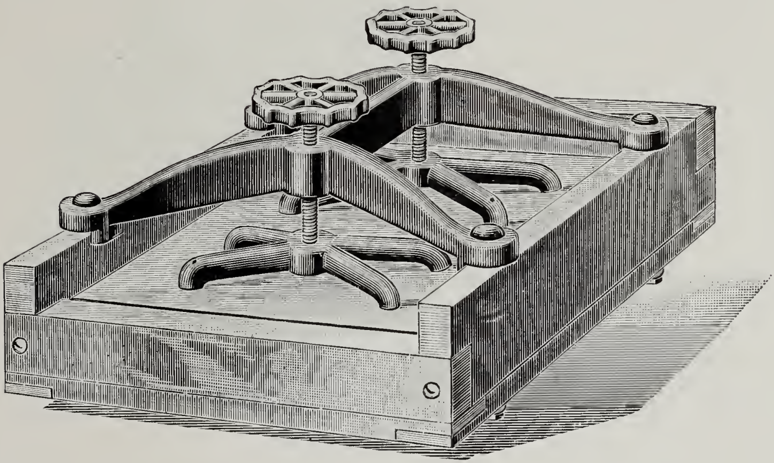


Fig. 52.

applied with wedges, another in which an air cushion was inflated at the back of the plate, and yet another in which hydraulic pressure was applied. Frames with a single central screw and a metal "spider" to distribute the pressure have been tried, but have never been successful in overcoming the prejudices of the printers. A much nearer approach to the ideal frame is one introduced by Penrose and Co. (fig. 52), in which there are two screws, threaded into a light steel frame which crosses the back of the box, the points of the screws

pressing against iron "spiders," which well distribute the pressure. There are also iron battens to strengthen the back of the frame. In America, Sweigard's frame (fig. 53) is very popular. The wooden back of the frame is covered with cylindrical sections of hard rubber, against which the pressure bars are forced

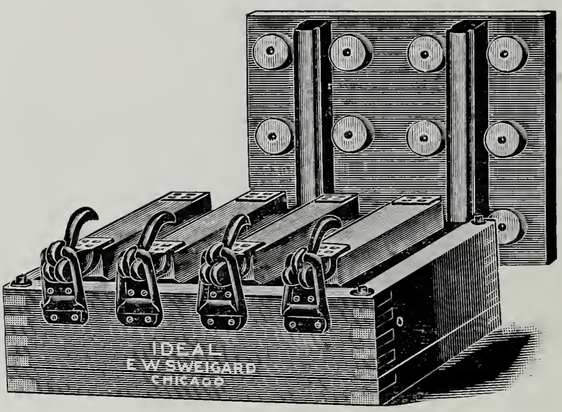


Fig. 53.

by means of a cam-shaped hook linking into a staple at the side. McLaughlin's frame (figs. 54 and 54A) is a distinctly novel one, as the front glass is hinged and the filling is done the reverse way of the ordinary frames, from the front instead of the back.

Whatever form of frame is used, a thick felt pad must be placed between the metal plate and the wooden back. Rubber is sometimes used instead, but it is expensive, and deteriorates very rapidly.

When the exposure is made to electric arc light it can be timed very accurately, but for daylight exposures it is best to use an actinometer. The simplest form is

as fig. 55. This consists of strips of paper so arranged as to form steps, No. 10 being ten thicknesses of paper. This forms a mask behind which a piece of sensitive paper is placed (ordinary P.O.P.) When a certain number (determined by experience) is visible on the sensitive paper, the plate will be fully exposed.

For what is called the "burning-in" of the plate

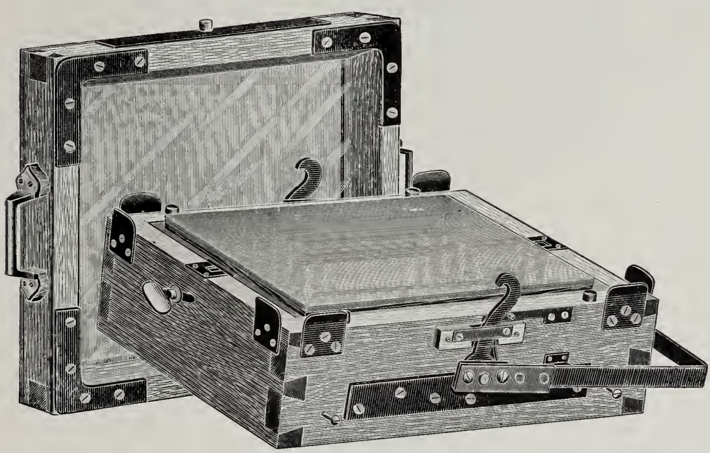


Fig. 54.

after development, a good stove is required. Whilst any ordinary gas stove will do which has a powerful and wide-spreading flame, it may be pointed out that there are now several stoves on the market specially constructed for the purpose. Penrose and Co. have a stove with three long straight burners (fig. 56) connected together, enabling very even heating to be performed. Recently the same firm have introduced a stove which can be used for any photo-process. The iron plate on the top is hinged so that the stove may either be used

as a hot plate for line etching or photogravure, or the top may be lifted up to permit of using the apparatus as an open stove for the "dragon's blood" process, or for burning in the enamel.

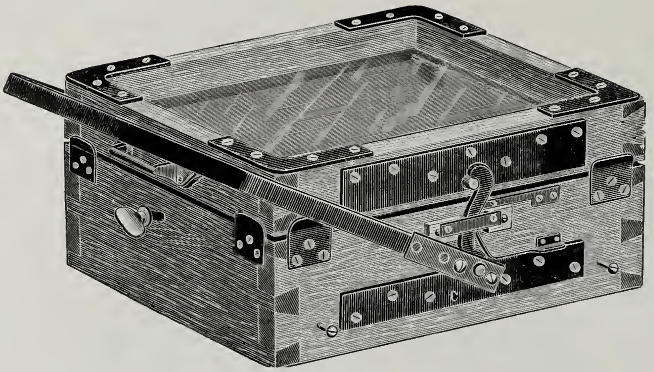


Fig. 54a.

It may here be mentioned that it is not considered practicable to use a hot plate for these two latter processes, owing to the great heat required and the slowness with which the heat would be applied.

Fig. 55.

The plate is handled with plate tongs (fig. 57), which are practically large pliers. There is an improved form with broad nose, which prevents the plates being bent so much in the heating operations. It has been suggested to have a kind of grid-iron for supporting the plate upon whilst heating, but it must be pointed out that any iron in contact with the plate absorbs and abstracts heat from it, causing patches of film which are not fully burnt-in. Ovens have been tried and have not been found successful. The almost universal practice is to use the open stove.

On the bench near the stove should be an iron plate with a piece of thick asbestos on it to lay the plate upon and allow it to cool. Some use the naked iron plate, or a lithographic stone, or a piece of wood. It is not right, however, to cool the enamel plate suddenly, as

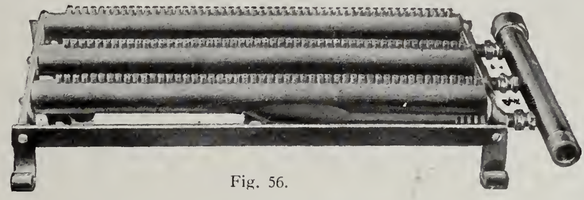


Fig. 56.

the film may be cracked and disintegrated by the sudden contraction of the metal, whilst a piece of wood will be charred by the great heat.

For polishing the metal plates preparatory to coating, similar appliances to those for cleaning glass may be

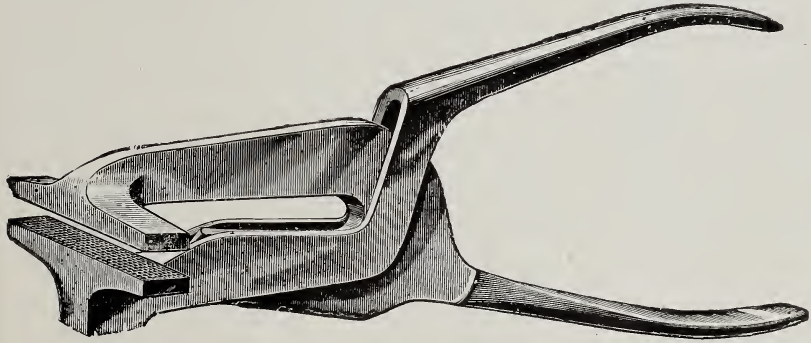


Fig. 57.

used. The plate vice is an excellent thing for small sizes, and for larger ones the curved board. A flat board covered with American cloth will also do very well.

A modification of the old-fashioned screw vice is to have a box with open top, and a couple of rails across to rest the plate on. One rail was fixed and the other moved up into notches cut at various distances. A rebate, corresponding to the thickness of the plate, was cut in the meeting edges of the bars, so that the plate was held from slipping off. The idea is right enough if the plates are cut to standard sizes, but as the zinc is cut to any odd measurements to fit the picture, such an arrangement would hardly be practicable. There is no reason why the vice should not be combined with the open box to receive the surplus powder.

For some methods of half-tone we require a graining bath. This may be either a porcelain dish on a rocker or a small etching tub. The porcelain dish can be made use of as a makeshift, but the plate is liable to slip about and an uneven grain is produced. The best arrangement of all would be a light wooden tray with a rocking arrangement actuated by a small clock-work or electric motor, so that whilst the plate is being grained other things could be got ready. A pendulum has been suggested, but it would have to be a very large and long one to rock for any appreciable time. If the tray is a wooden one it must, of course, be pitched or coated with guttapercha to stand the acid. The tray should be as large again in area as the largest plate to be used.

As the albumen process is sure to be used either partially for half-tone or wholly for line work, there

will be required on another part of the bench well away from the stove and sink a couple of litho stones, one for the ink and the other with a pad of sheet rubber on it, the object of this being to hold the plate from slipping about whilst it is being inked, the stone providing a firm bed.

Behind the ink slab or underneath the bench should be a cupboard to keep the composition roller used for this process free from dust. In the same cupboard may be kept the ink. The roller will keep better if there is a little ventilation in the cupboard.

The roller should be of the letterpress kind (fig: 58) with forked handle, and the composition of a water-resisting nature, and not too soft. If tacky it will stick to the plate and pull the film off. A tacky roller may be improved for immediate use by rubbing it all over with powdered magnesia applied with the palm of the hand. To make a roller less susceptible to changes of temperature it should first be cleaned free from grease or ink by means of turpentine, then washed with methylated spirit applied with a sponge, and when dry sponged again with a solution of ordinary alum, chrome alum, or tannic acid.

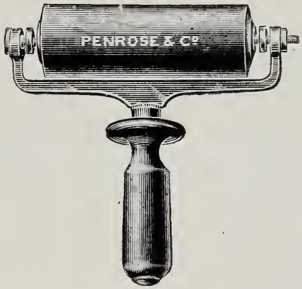


Fig. 58.

Indiarubber rollers can be used instead of composition ones, but it is difficult to keep them in good condition. They are apt to become hard, dry, lumpy,

or cracked. They should be cleaned with paraffin to remove the ink, and then sponged with water containing an alkali, such as washing soda, ammonia, or potash. Oil is very injurious to rubber, and benzine or naphtha dissolves it.

Some practical men use a good lithographic leather roller, with very dry close skin and fine nap, for rolling up albumen prints. The ink must never be allowed to become too thick on such a roller, and it must never be thinned down with turpentine as is usual with the composition roller—it must be used full strength, or, at any rate, only thinned by careful mixing with a little grease or thin varnish. It is better to have two rollers, one being used to get the ink well distributed, the other for applying the ink to the plate. The author, however, does not recommend leather rollers to be used, except by those who are accustomed to them and expert in their manipulation. Leather rollers, moreover, want to be in constant use to keep in good order.

A set of ink knives are requisite accessories to the ink slab. Fig. 59 is a palette knife for mixing, fig. 60 an ink knife for taking the ink out of the tins, and fig. 61 a "push" knife, so called by reason of its being pushed forward to scrape the ink off the slab. A little bridge of wood to rest them on when smeared with ink is an aid to cleanliness, and

Fig. 59.

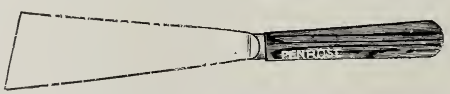


Fig. 60.

may be easily constructed by anyone. A cover for the ink slab, in the form of an inverted box, should be provided, as it is most important to keep the slab free from dust.

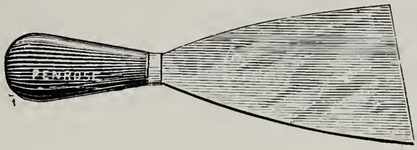


Fig. 61.

For the dry enamel process, and for photo-lithographic transfers, some additional appliances will be necessary, but these are best left to be described in the instructions for these processes.

CHAPTER VI.

THE ELECTRIC LIGHT INSTALLATION.

IN large towns and cities it has now become so general to do all work by means of the electric light, that it seems necessary to indicate the points to be considered in making an installation. If the studio is near the mains of an electric supply company matters are fairly easy, and it is most economical to take the supply in this way instead of generating it one's self, especially as most supply companies give special rates to photo-engravers.

When it is not possible to get a supply from the street mains, it will be necessary to have a steam, gas, or oil engine, and it is usually requisite to have also a battery of accumulators in order to get a steady current.

It may be taken as an approximate basis of calculation that 5 h.p. will be required to run two copying lamps and one printing lamp of the intensity necessary for photo-engraving, but $3\frac{1}{2}$ h.p. would be sufficient if only a pair of copying lamps were run, one or both of these being used also for printing.

The exact horse-power required depends a good deal on the efficiency of the dynamo. If, for instance, the

efficiency is 80 per cent., we must add 20 per cent. to the power we estimate the lamps to be taking.

Again, the power depends on the arrangement of the lamps, whether in "series" or "parallel." If a 60 volt dynamo is used, there will be no alternative but to run the lamps in "parallel," that is to say, each with its own separate circuit and switch, because each lamp requires about 45 to 50 volts to maintain its arc, and we require the surplus 10 volts for the steadying resistance. Two lamps in "series" would require 100 volts, and three in "series" 150 volts, but whereas in the case of two or three lamps in "parallel" 50 or 75 ampères would be required at 60 volts pressure, only 25 ampères would be required at 100 or 150 volts pressure for two or three lamps in "series."

It is usual to run copying lamps at 25 ampères, and printing lamps at 30 ampères and upwards. It is somewhat difficult to explain these terms "volts" and "ampères" to the reader who is unacquainted with electrical matters, and it will be sufficient to define "volts" as the pressure necessary for effective working in the same way that we refer to pressure of water, gas, or steam; and we may define "ampères" as the quantity of electrical energy flowing, just as we may have a large quantity or a small quantity of gas issuing from pipe, and thereby get a large or a small flame, whilst the pressure of gas from the company's mains remains the same. It follows that the greater the ampèrage the greater the intensity of light provided. Of course, the lamps must be constructed and adjusted so as to take full advantage of the increased current.

One fact must be borne in mind, viz., that whatever the ampèrage may be the voltage must remain constant at about 45 volts per lamp on continuous current, and about 35 volts on alternating current. The latter current is not likely to be used in private installations, so that our remarks may be taken throughout to refer to continuous current unless otherwise stated.

Coming back to the question of the best arrangement of lamps—" series " or " parallel "—it will now be seen that this depends a good deal on the voltage. At 60 volts "parallel" arrangements can only be used; at 100 volts it would mean a great waste of energy to put them in "parallel," as 50 volts or more would have to be dissipated by means of a resistance coil with each lamp, and a further consideration would be that the dynamo would not give out a sufficient ampèrage.

This rule must be remembered: In "parallel" working the volts remain practically constant for any number of lamps, but the ampères add up. If one lamp requires 25 ampères, two lamps require 50, and so on. In "series" working the volts add up whilst the ampères remain constant. If one lamp requires 45 volts, two require 90, and so on, but the ampères are the same for any number of lamps, as the current passes from one into the other.

This point is important when estimating the power required to drive a dynamo, and also in determining the cost of the current from the street mains, because the volts and the ampères multiplied together form

another electrical quantity termed "watts." Now, 746 watts are equivalent to one horse-power; hence it is fairly easy to understand how the horse-power necessary to run arc lamps is arrived at. For example: Two arc lamps consuming 25 ampères in series on 100 volts are taking 2,500 watts, and if we divide this number by 746 we get a quotient of 3·35, so that we are justified in saying that, allowing for efficiency losses in the dynamo and engine, we cannot do with less than 3½ h.p., and that would be cutting things rather fine. Of course, the power can be reduced by running lamps of less ampèrage, but that means longer exposures, and it is believed that a low intensity of illumination does not have the same effect on the sensitive plate, even when the exposure is prolonged.

When the current is taken from the street mains the supply companies in this country charge a certain rate per Board of Trade unit. This consists of 1,000 watts running for one hour. For example: A pair of 25 ampère lamps, on 100 volts, allowed to run for one hour would consume 2½ units; or if allowed to run for only half an hour 1¼ unit. If the price is 4d. per unit, the cost of running a pair of 25 ampère lamps on a 100 volt supply for one hour will be 10d. The charges, however, vary in different towns and districts, and in some towns even so low a rate as 2d. per unit is charged as a special rate to photo-engravers.

Of late years it has become usual for the electric supply companies to provide their current at 200 to 220 volts, and in such case there would be a consider-

able waste in putting a pair of lamps in series on such a circuit. Four lamps in series would cost no more than two to run, but if the consumer has no use for the two extra lamps, his case is best met by having special lamps which take up a higher voltage. There are now on the market "double carbon" lamps, and "enclosed" lamps, which meet this requirement.

Remembering that each pair of carbons take 45 to 50 volts, it will be seen that a pair of double carbon arcs will take up the 200 volts, just as easily as the single carbon lamps took up the 100 volts, and as four pairs of carbons with 25 ampères would obviously give double the light of the pair of single carbon lamps, we may reduce the current to 12½ ampères, and so make the watts consumed remain the same.

So far we have dealt only with the ordinary or "open" type of arc lamp, in which the arc is naked—not enclosed in any glass bulb or globe. Within the last two or three years there have come into use what are known as "enclosed" lamps. In these the arc is enclosed in a small glass cylinder or bulb, and the ends of the latter fit so closely that the air inside is soon consumed and no further supply can enter. The arc then burns in a gas formed by the products of combustion. The result is that a longer arc is formed and more volts are taken up—in fact, about 75 to 80 volts—whilst at the same time less current is required. For example, such lamps are run with about five or six ampères, and if a pair are in series on 200 volt circuit, the watts consumed at six ampères will be 1,200, so

that the working of these lamps is very economical. On 100 volts the lamps must be in "parallel," and the watts consumed will be the same, viz., 600 per lamp, making 1,200 watts for the pair. It would not be fair, however, to compare them with the open type at 25 ampères unless we can be assured that the six ampère lamps give a light equal to the 25 ampère lamps. On this point there is considerable doubt at the time of writing. It is claimed that the enclosed arc being richer in violet rays is more actinic, and, moreover, the arc is longer and gives a greater volume of light. A further advantage of the "enclosed" arc is that the consumption of the carbons is very slow, the life of a pair of carbons under these circumstances being about sixty hours. Both carbons are alike in diameter, and burn with flat ends, instead of having pointed ends as in case of the alternating current, or a pointed end on one and crater on the other as in the continuous current arc.

It may be here mentioned that in continuous current lamps the top or positive carbon is thicker than the bottom or negative carbon, the rule being that the top one has twice the area of cross section of the lower. The reason of this is that the positive carbon is consumed twice as fast as the negative. The top carbon is always "cored"—provided with a core of softer material—which tends to assist the formation of the crater, and keep it central. The bottom carbon is solid, and burns to a long tapering point. In the alternating current lamp there is no positive or negative, or,

correctly speaking, each carbon alternates from positive to negative, being positive for a moment, then negative, and repeating the cycle of change for 50 or 100 times per second. That will roughly explain the terms "periodicity" or "frequency" of the alternating current, which is the number of times the current makes the cycle of change from positive to negative. In some towns it will be 50, in others 80 or 100 cycles per second, and it is necessary in ordering lamps for alternating current that the "periodicity" should be stated, as a lamp arranged for 50 cycles will not work on 100 cycles. The voltage should also be stated in ordering lamps whether for "continuous" or "alternating" current.

It is desirable to order a supply of carbons with the lamps, as there is a great difference in the quality of carbons, and bad ones may entirely neutralise the adjustment of the lamps, besides hissing, spluttering, flaring, and possibly cracking and crumbling away, doing anything, in fact, but giving a steady white arc. A good pair of carbons is almost silent, and the residue from it is in the form of very fine black dust.

The length of arc—equivalent to the distance between the carbon tips—has a very important influence on the amount and character of the light, as also has the accurate centring of the carbon points to one another. A long arc will give a violet light with a flaring yellowish flame round the carbons. A short arc will cover up the white incandescence from which issues the most actinic

light, and the arc will for the most part consist of red and yellow fringes. It has been well established by scientific investigation that the best light comes from the crater of a continuous current arc, and this light most nearly approaches the qualities of sunlight. It is accordingly a good plan to set the carbons so that the crater is thrown forward, either by inclining the carbons in opposite directions, or by setting the bottom carbon a little in advance of the top.

The length of arc is usually about $\frac{3}{16}$in., and it is a good plan to have a screen of red and green glass combined, so that the arc can be viewed. Messrs. Penrose and Co. sell a little pocket folder for the purpose—very much like a pocket magnifier, but with coloured glass discs. It is not wise to allow one's naked eyes to be subjected to the glare of the arc light, and, indeed, it will bring on temporary blindness and great pain if persisted in. The lamps should be shaded with reflectors, and if the arc is directly examined a pair of smoke-tinted goggles should be put on, or some form of coloured glass screen held before the eyes.

A point to be remembered in placing the lamps in relation to the copy-board is that with continuous current lamps the light is thrown downward from the crater of the arc, the best rays making an angle of about 60° to the axis of the carbons. The lamps should accordingly be hung so that the arc is above the centre of the copy-board, the best position being found by trial, it being quite easy to see when the board is well illuminated. Any reflector surrounding the arc must

be inclined forward. In the alternating current arc the light issues in radial lines equally above and below the arc, which should consequently be placed opposite the central line of the copy-board. The reflector should be placed vertical.

The form of reflector is somewhat important. The best possible is one not quite of a parabolic shape. If quite parabolic, and if the light were placed at the focus, the rays would emerge in a parallel beam, and would only give a small disc of illumination on the copy-board. But by making the reflector a combination of a sphere and a parabola, and placing the light nearer in than the true focus, a divergent beam is obtained, subtending an angle of nearly 90°, the copy-board being consequently very evenly illuminated. Messrs. Penrose and Co. first introduced these semi-parabolic—as we may call them—reflectors, and have been very successful in adapting them to arc lamps of various patterns (figs. 62 and 63). There is no doubt, also, a great gain in concentrating the light and throwing it forward to the copy-board, instead of merely screening the back of the lamp with a sheet of tin or zinc, as was done formerly. Still, the latter plan is better than nothing at all, as it prevents stray light getting into the camera.

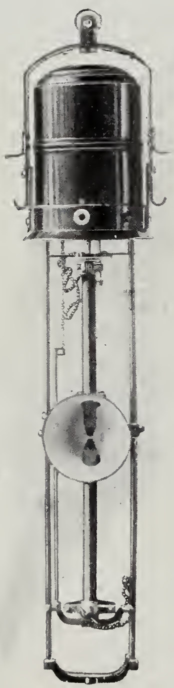


Fig. 62.

Whatever reflector is used it must be dead white inside. In most cases a coat of whitewash serves very well. Bright reflecting surfaces do not illuminate the copy evenly.

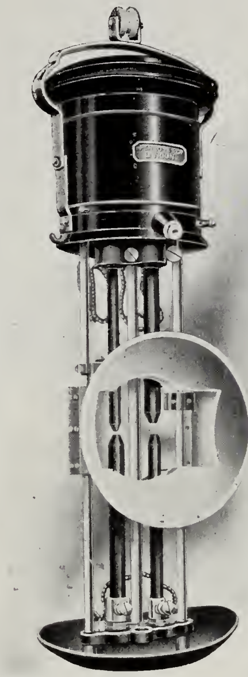


Fig. 63.

In regard to the choice of lamps, some care must be exercised to get a suitable type. If left to the electrical contractor he may put in a form which may be very well suited for street or general lighting, but not fitted to the needs of the process worker. The lamp itself may not have been made to carry so heavy a current as 25 ampères, street lamps generally running about 10 to 15 ampères, and although the lamp may be adapted by changing the coils and carbon holders, it is never so satisfactory as a lamp designed for the current it is intended to carry. Again, the street lamps are not expected to be so sensitive in feeding the carbons together as they are consumed away, and in some cases this operation is performed in jerks, or, in popular parlance, by "fits and starts." Another disadvantage is that these lamps are usually big and clumsy with respect to the case at the top of the lamp, so that

where there is little head room the lamps cannot be suspended high enough. It may also be difficult to remove the case in the event of anything going wrong.

One most important point to bear in mind is that whatever type of lamp is selected it must be one in which both the carbons move together—what is called a focussing lamp. In some lamps the bottom carbon is fixed and only the top one moves. In such a case it would obviously be useless to have a parabolic reflector, as the arc could never be kept central in it, and even without a reflector the lamps would have to be raised and lowered as the carbons were burnt away.

The form of lamp to be recommended, therefore, is known to electricians as a "differential self-focussing lamp." The word differential implies that there will be a pair of coils in the lamp which will balance against each other, any sudden change in the one being compensated in the other. One of the coils will be of thick wire, known as the "series" coil, through which the whole of the current will pass on its way to the carbons. The other will be of thin wire, known as the "shunt," and will form a byepath for the current. If a large amount of current passes through the "series" coil, there will be a correspondingly large current in the "shunt," and as they cause their magnets to rise and fall like a scale beam, the one will balance the other, and the feeding motion will be very sensitive and gradual during the whole time the lamp is working. The simpler the mechanism in the lamp the better,

but it must at any rate be sufficient to ensure a uniform feed. Operators should endeavour thoroughly to grasp the principle of the feeding mechanism of their lamps, and to trace out the path of the current, so that they may readily know what to do in case the lamp "sticks" in any way.

Carbon holders should preferably have some form of spring clamp, as the grip slackens when the holders get hot, owing to expansion of the metal and contraction of the carbon. A loose contact will often cause sparking and eventually "arcing" on to the holder, with the result of its being fused and rendered useless. It is advisable to tighten up screws when the lamps have heated up, and the carbons will then remain tight. The bottom carbon holder, at least, should have a ball and socket joint for more readily centring the points of the carbons.

A word must be said as to the necessity of having two lamps to illuminate the copy evenly. As the lens must point centrally to the copy, it is impossible to place one lamp in the best position for obtaining the maximum amount of light, *i.e.*, opposite the centre of the picture. It must accordingly be placed at one side, with the result that if the copy is more than a foot across, the further side is unevenly illuminated, and shows as a patch of less density on the negative, the dot formation in the half-tone being entirely different on one side from that on the other. There may also be trouble due to reflections from the surface of the copy if the latter is at all glossy, or from the grain of the

paper if rough. These troubles are worrying enough with two lamps at times, and will be greatly increased with one lamp. Of course a good deal may be done by the use of a reflector on the opposite side to the lamp, or by having the lamp on a travelling pulley, so as to push it over to the opposite side midway in the exposure. But these are at the best makeshift arrangements, which result in many spoilt negatives.

The plan which is universally adopted is to have two lamps, which are usually placed about two feet from the board, and about four to five feet apart. These distances have to be varied for very large copies on the one hand, or extreme reductions on the other. The points to be studied in placing the lamps are: (1) to see that they cause no shiny patches on the copy, which can be discovered by examination of the image on the ground glass; (2) to have them as near as convenient to the copy, remembering that doubling the distance makes the intensity one fourth, trebling the distance one ninth, or, as it is expressed scientifically, "the intensity of illumination varies inversely as the square of the distance"; (3) to see that the illumination is equal from both sides, which may be determined by holding a pencil in the centre of the copy, and noticing if the two shadows cast by the lamps are equal in depth of shade.

For illuminating a very large copy-board it is a good plan to have four lamps, two being above and two below the centre line of the board. If the current is continuous, it is further a good plan to reverse the carbons

in the bottom pair of lamps, and reverse the order of the cable connections, so that the bottom carbon becomes the positive. In this way the light is thrown upwards from the lower lamps and downwards from the upper ones, ensuring a very even illumination. This also is a good arrangement for dealing with a two

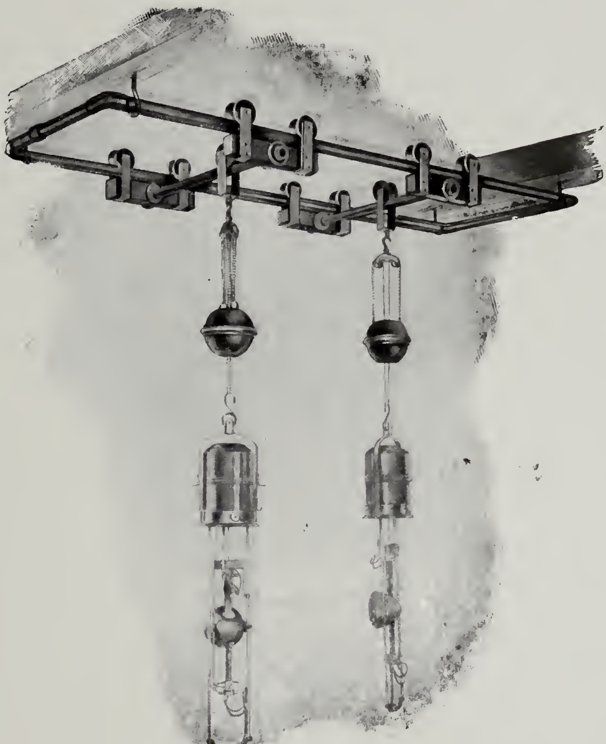


Fig. 64.

hundred volt supply, as all four lamps can be run in series, and cost no more to run than two lamps.

To facilitate the adjustment of the lamps it is desirable to have a traversing gear, such as herewith illustrated

(fig. 64), if a suitable fixing for the same can be obtained overhead. This enables the lamps to traverse to and from the board independently and together, also permitting them to be moved nearer together or further apart, and provides for raising and lowering by means of a counter-weight, so balanced that the lamp will stop at any point.

In many studios where it is inconvenient to have an overhead gear, a floor standard is used for each lamp, and some operators prefer them in any case. They certainly have the advantage that they can be moved about to any part of the studio. A good type of stand which permits of the hanging type of lamp being used is shown in fig. 65. The rod can be raised and lowered, and a clamping collar on the rod enables the lamp to be swung round without lifting the stool.

Fig. 65.

In America the form of lamp illustrated in fig. 66 is very generally used. The exact pattern will vary with different makers, but all are alike in principle. These lamps are, as a rule, much dearer than the hanging ones, and have no advantages except, perhaps, in the fact that the lamp can be tilted.

For printing the photographic negative on to the metal plate the same lamps may be used, but it is

generally more convenient to keep the printing department separate, and to use a single lamp of higher power. Not less than thirty ampères is advisable, and forty or forty-five ampères is better if quick work is required. Although it is quite the usual practice to use one lamp only for printing, it means an absolute waste of current on a 100 volt circuit, because just as much energy is wasted in the resistance as is used in the lamp. It will cost no more to run two lamps in series, and put them close together if only one frame is being exposed. The "double carbon" lamp previously referred to makes an excellent printing lamp, and entails no waste of current. The "enclosed" lamps are also much used, and it is believed that quicker exposures are obtained by their means, owing to the sensitive film being strongly affected by the violet rays which these lamps throw out.

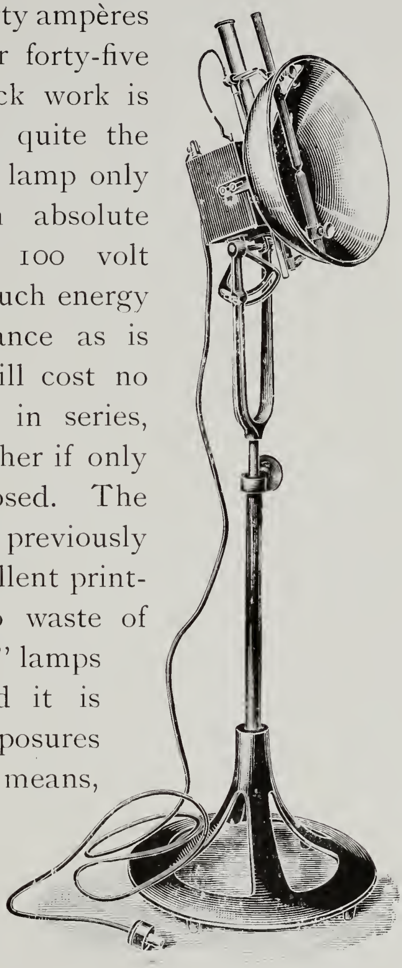


Fig. 66.

A word must be said about the resistance coils, which are in all cases necessary for cutting down the voltage of the supply. These should always be ordered

with the lamps, as the vendor has no interest in supplying anything but that which is suitable for the purpose, and they will usually be sent out adjusted to suit the lamps. Although these resistances are made with an adjustment which permits more or less current being passed, it is not wise to tamper with them, as they may be very easily short circuited and burnt out. Any adjustment of the resistance should be done with an ammeter in circuit. The resistance coils generally used for arc lamp work consist of a German silver wire wound round a porcelain cylinder. Such coils can be used either for continuous or for alternating current, but it is best in the latter case to use what are known as choking coils, which consist of a coil of insulated wire with an iron core, this latter being either a bundle of iron wire or of flat iron plates. Choking coils have the great advantage over ordinary resistance coils that they do not waste all the energy they "choke." An efficient coil may save as much as 40 per cent. of the energy which would be wasted in an ordinary resistance coil.

Resistance coils, or choking coils, get hot whilst the current is passing, and the novice need not be alarmed at this unless he sees the German silver wire red hot or the insulated wire of the choking coil smoking, as it is the function of these coils to dissipate electrical energy by transforming it into heat.

The various details connected with the wiring need not be entered into here. They are best settled with the electrical contractor, but the writer cannot too

strongly impress the necessity of sparing no pains nor reasonable expense to ensure a thoroughly reliable electrical installation, as upon this the whole success of a business will depend in the case of rapid commercial work.

CHAPTER VII.

THE ETCHING ROOM.

ALMOST any well-lighted and well-ventilated room will do for etching purposes, but if I were building a room for this express purpose I should, for preference, have it on the ground, with the floor laid in concrete, having a " fall " to a drain at one side or in the middle, and in erecting the roof give it a ventilating ridge the whole length. It is not necessary to have the lighting from the top; it would be best to have a long lofty window down each side. One end would receive the entrance, the other would be provided with a long sink. Down one side of the room under the window would be the fine etchers' and engravers' bench, unless these workers are provided with a separate room. On the other side the inking-up bench and powdering boxes. Near the inking-up bench, or on it, should be the hot plate, and it is good to have a flue over it to carry off the fumes. I have in the subsequent part of this chapter fully described the apparatus for the rolling-up process, though many think it obsolete. But in a half-tone establishment it is often necessary to do a little line work, and the glazed roller is frequently in requisition for fine etching half-tones. Down the middle of the room would be the etching tubs.

With respect to the fitting up there would be first of all in the corner near the door a brick ledge, covered with asphalt paving composition, of about six inches high, for the acid carboys and perchloride jars. Acid carboys should either be fitted with a syphon, or, better still, the carboy in use should be provided with an iron stand (fig. 67). The carboy is fixed in the swinging basket, and anyone can pour from it without assistance, and without danger of spilling.

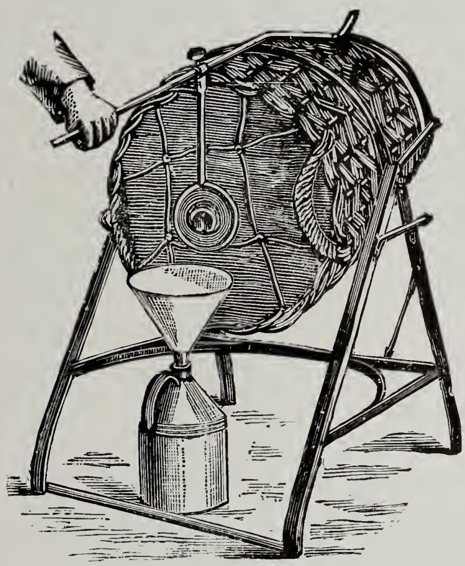


Fig. 67.

The sink should be roomy, and of a very substantial character. It is usually of wood and heavily lined with lead. The joints should be "burned," not soldered. In many large etching rooms these sinks are about six feet by three feet, and perhaps twelve to eighteen inches deep, but in a small room, where the plates handled are not more than 15 x 12, a sink about 4ft. x 2ft. 6in. is big enough. If economy is desired a wooden sink pitched inside is the most readily made, and is really very serviceable. A deep earthenware sink is the most durable and cleanly, but cannot be obtained in very large sizes. It may be fitted up as described for those in the dark rooms.

Lead-lined sinks are soon eaten through, despite the idea that nitric acid does not attack lead. The drain pipe should, if possible, be of earthenware for the same reason. Doulton's make enamelled tubes two feet long by two inches diameter, which are excellent for draining acid sinks, and traps, bends, and connections can be obtained to match the same. The joints must be caulked with pitch.

At one end of the sink, covering about two feet of it, should be a grid of teak or oak, or of iron rod. This is for scrubbing the plates upon with potash, turps, etc. It will get such a greasy coating in use that there is little fear of the iron rusting or the wood rotting. A shelf should be provided at the side or back of the sink for the brushes, cans, and pots used for the cleaning operations, and a stove should be close to the sink to heat the plate, as this assists the cleaning. A stand pipe fitted with tap, rubber hose, and rose sprinkler, each, if possible, with separate connections, will form the water supply, and it should be fixed clear of the scrubbing grid, so that it will not be in the centre of the sink.

To rest the etching troughs on, the best thing is a strong wooden bench with a slate slab to form the top, as slate resists acid and chemical solution very well. The next best thing is teak wood.

If a large amount of continuous rocking has to be done, it is a good plan to have a mechanical rocking stand with a row of baths on it. Various methods will suggest themselves for obtaining the rocking motion.

Where power can be obtained it may be done by means of an eccentric and connecting rod on the overhead shafting, or the eccentric may be placed on the driving axle of the stand, or on the pivoting axle. Here is an illustration of a stand which may be taken as typical of such arrangements (fig. 68). The lever at the side enables the rocking motion to be stopped without stopping the motive power, the tub being thrown out of connection with the crank.

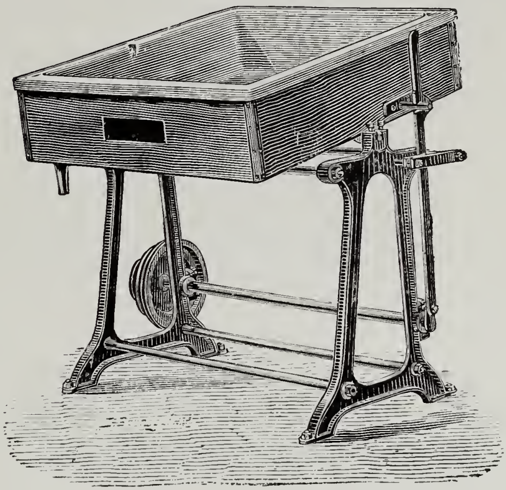


Fig. 68.

For the etching troughs, trays, or tubs (as they are variously called), the rectangular wooden box with splash board over each end is easy of construction, but is not satisfactory, as the vertical ends cause splashing. Sloping ends, as shown in fig. 69, are much better, and give a

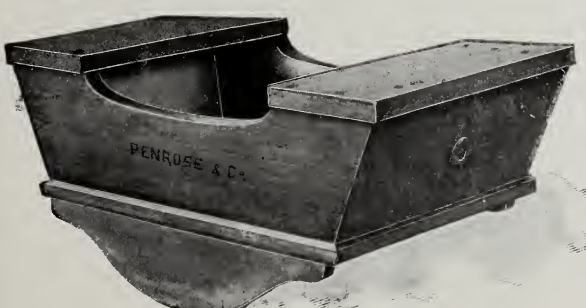


Fig. 69.

more even wave. Wooden baths in any case must be coated with pitch or lined with sheet gutta-percha well jointed. The lining with guttapercha

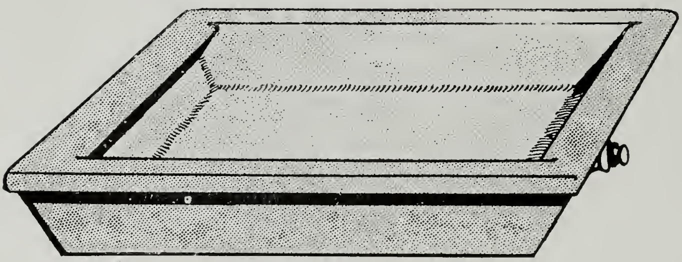


Fig. 70.

should be done by a manufacturer of rubber goods, but the pitching may be done at home, though my readers will be well advised if they avoid the operation and buy a ready made tub. Marine glue makes a good acid resisting coating, but it is difficult to apply, liable to run and form ridges when the acid is used strong, as heat is generated. Pitch is also softened by the heating caused by the action of strong acid.

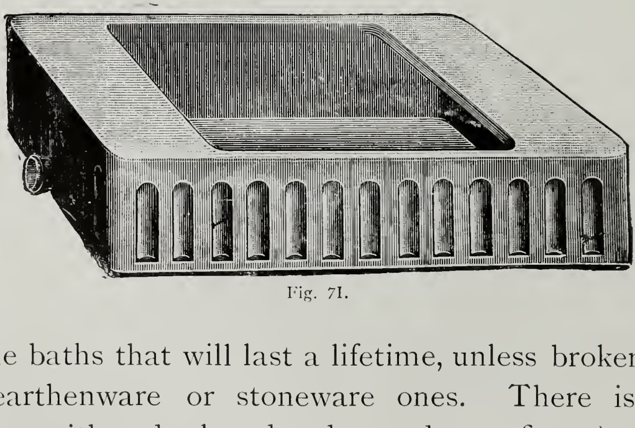


Fig. 71.

The baths that will last a lifetime, unless broken, are the earthenware or stoneware ones. There is one pattern, with ends sloped and turned over (fig. 70), which

is very good and cheap. Messrs. Doulton also make a bath of the rectangular shape, with straight ends covered to prevent splashing (fig. 71). As these stoneware baths are heavy to lift about for emptying, they are provided with a bung hole at the end. By having these baths on a stand and a half-round earthenware gutter arranged just under the bung-hole there will be no necessity ever to take them off the stand, or to use buckets or other vessels, and there will be no risk, therefore, of breakage or spilling.

For etching with perchloride the same kind of stoneware troughs are used in many establishments, but as some think it is not necessary nor desirable to rock the bath of perchloride of iron solution, shallower stoneware or porcelain trays are used; in fact, ordinary deep porcelain trays serve very well.

There is some advantage in etching copper in a perchloride bath face downwards, and for this purpose a handy little wooden clamp is sold, which grips the plate by the edges, and prevents it touching the bottom.

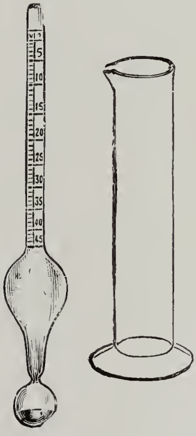


Fig. 72.

A very necessary accessory for the perchloride etcher is the Beaumé hydrometer (fig. 72). This is a glass float with a paper scale inside, graduated from 0° at the top to 50° or more at the bottom. The solution is placed in a tall cylindrical glass jar, and on the hydrometer being placed therein it sinks to

the degree on the scale which denotes the density of the solution.

For filling the bath it is a good plan to have a vessel of known capacity. Heavy earthenware jugs are best for the purpose. They are specially made for handling acid solutions. Although the general plan is to add acid by the eye and rule of thumb, the author strongly advocates measuring. Even though it need not be very exactly done, it is better than guesswork. It would be even better to work by hydrometer in the case of nitric acid etching in the same way as is done for perchloride etching. At any rate it is easy to have a vessel which shall represent one hundred parts when filled, and a smaller vessel for the acid to be measured off in the same parts. By this means the acid may be added at a strength of so much per cent. without any troublesome calculation.

For heating and drying the plates during the operations of etching, a stove in the form of a hot plate is required. For burning-in enamel plates and for heating after dragon's blood powdering, an open stove is requisite.

In some large studios a planed cast iron plate, standing on a brick foundation if possible, somewhat like a blacksmith's forge, is used. This may be constructed by taking a printer's iron imposing surface and standing it on a box of brickwork, with only a trap in front for lighting up the gas rings and a ventilating shaft behind. It must be borne in mind that to get uniformly diffused heat in such a plate there must be a deep

turn-down rim round it in order to concentrate the heat. This may be made by bending around the plate a descending rim of sheet iron and rivetting the same on. Also remember that there must be ventilating holes on a level with the gas rings, or the burners will be put out by the absence of pure air. It is a good plan to have two or more rings, each with a separate tap, so that only a part of the plate may be heated if all is not required.

A sheet of asbestos board is a good thing to lay on the hot plate to modify the heat, and one or two pairs of large pliers should be hung up in a convenient place near the hot plate for handling the plates when hot. There are plate tongs specially made for the purpose.

For cooling the plates rapidly the arrangement shown in fig. 73 is ingenious. The trough contains water (and ice in summer). The rollers dip in and the top of the roller is out of the water. The back of the heated plate is passed to and fro over the rollers two or three times until cooled. In the dragon's blood process, where there are many heating and cooling operations, this appliance is very handy.

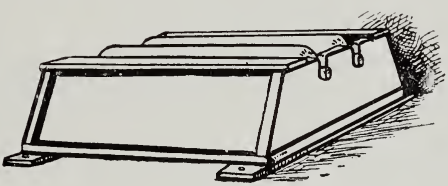


Fig. 73.

Another way of cooling the plates is to have a bellows for giving a cold blast of air. This can also be used for blowing off the surplus resin, asphaltum, dragon's blood, etc., in powdering processes, and for

drying off the gum coating in the rolling up. An electric fan is the most modern improvement.

For powdering the plate with resin, bitumen, or dragon's blood, the powder may be in a shallow tray, or a box may be used with a grid about the middle of it on which to support the plate whilst brushing (fig. 74).

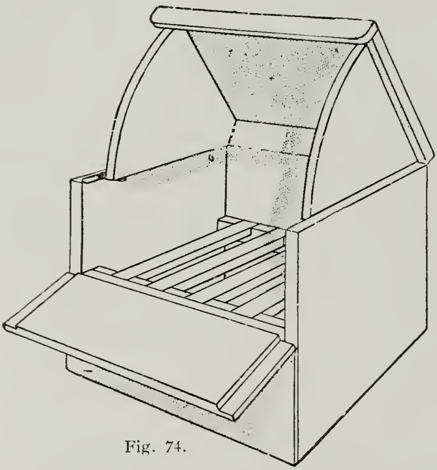


Fig. 74.

Where much powdering has to be done it is better to construct a box about six feet high by three feet wide by about two feet from back to front, and have a sliding sash in the front of it. On a level with the bottom of the sash inside, a tray is formed to the full area of the box. The powder lies loosely in this, and the brushes hang up on the walls of the box. When a plate has to be powdered the sash is run up, and when finished shut down, so that no powder can escape. Sometimes a window at the side, top, or back is provided, and illuminated with an electric lamp.

In some studios the powders are kept in drawers under the bench, and these are drawn out when required.

The nature of the brushes used for powdering is important. They are flat, very full of hair, and very soft. The hair appears to be a mixture of various kinds, evidently in order to get softness combined with

the necessary springiness. Sometimes the end of the brush is bevelled off at each side so as to suit the angle at which it is held in powdering. Fig. 75 shows the form of brush sold for this purpose.

For nitric acid etching on zinc a soft bristle brush, flat, about two and a half to three inches wide, is used, and the handle should be thickly varnished, or the bristles bound in with rubber (fig. 76). There must be no metal in the mounting. These brushes are used to clear the scum from the plate as soon as it is formed in etching.

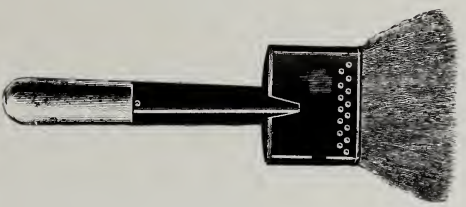
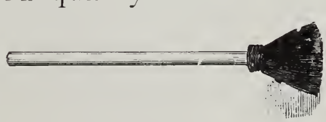


Fig. 75.

Bear, badger, marten, or skunk hair seems to stand acids best, being of an oily, resinous nature. Camel hair is soon rotted. Small round brushes (fig. 77), bound with waxed string and shellac coated, known as "ätzpinsel" in Germany and Austria, are to be had cheaply, and are of marten fur. In default of these a good quality of flat camel hair dusting brush may be taken as a makeshift, and the handle thickly coated with shellac varnish.

Fig. 76.



g. 77.

The rolling-up bench should not be too high, or it

will not be possible to get a good downward pressure on the roller. The top of the bench should be quite $1\frac{1}{2}$in. thick, and well supported underneath, so that it does not spring when the roller is knocked up on the slab. A few drawers underneath are useful for containing fresh supplies of rags, sponges, and sundries.

To fit up this bench for the rolling-up process we require first of all near the hot plate a cooling slab, unless the wet cooling box is made use of as already described. One or the other may be dispensed with, but it is a convenience to have both. Sometimes the plate is bent in the heating, and it may be straightened by pressing it down against the cooling slab by means of the ends of the plate tongs. Iron is better than anything else for cooling purposes, and the larger the slab the less chance there will be of its becoming warm by constantly laying upon it the hot zinc plates. A large litho stone is sometimes used as a substitute.

Next to the cooling slab will be the rolling-up stone, which will be an old litho stone of good size, with a sheet of indiarubber cloth on it to prevent the plate slipping about. Adjoining this will be an ink slab, this also being an old litho stone. At the back of this some sort of rack should be found for the rollers. Wooden brackets can be obtained for the purpose. A simple way, however, of standing litho rollers is to drill two or three holes in the bench large enough to put the handles through, so that the rollers stand on end.

The rollers will be at least two for each workman: one a "nap" leather roller, and the other a glazed one,

both of the litho type (fig. 78). These rollers are formed of a solid cylindrical block of soft light wood, with handles of a harder wood, well driven and glued into the block. Sometimes, however, the block with its handles is turned out of the solid. The latter is first covered with flannel, over this is put calf-skin leather. In the case of the "nap" roller the smooth or skin side is placed inside, the "nap" having a more or less rough surface which holds the ink.

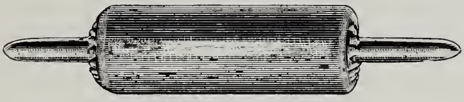


Fig. 78.

To prepare a new roller for use it must first be rubbed with Russian tallow before a fire, heating the roller well and rubbing the fat in until it will absorb no more. Schmautz, the well-known French roller maker, recommends for his rollers only rolling up in "middle" litho varnish until saturated, then with good black ink. Next apply some "strong" litho varnish, and knock up well on the slab until the varnish is evenly distributed on the roller. Now scrape the varnish off with a blunt knife held nearly at right angles. If the knife seems to drag and ruffles the nap, it will show that the scraping is the wrong way of the grain. If the scraping goes smoothly, mark the handle towards which the scraping is being done, and always scrape this way. After this varnishing, the roller is daily rolled up with litho ink, and scraped until ready for use. The roller should be put away with the ink on it, and scraped before being rolled up with fresh ink.

There is no satisfactory way of making a glazed roller quickly. The way usually described is to get a roller with the skin side outwards, and roll up in an ink mixed with some hard and quick-drying ink and varnish. Red lead, gold size, and siccatives are used for the purpose. When perfectly dry, smooth down with glass paper, and repeat this process of rolling up and rubbing down until a smooth hard surface results. Simple as this method of preparing a glazed roller appears, it is hardly likely to be satisfactory enough to fit the roller for immediate use ; because the skin side of the leather always shows wrinkles which cannot be completely filled up. Experienced etchers know well that the best glazed roller is an old lithographic colour roller which has become glazed and hardened by use.

Roller handles are formed of tapering tubes of leather, which fit on to the handle of the roller, and so prevent the hands becoming sore through friction.

An indiarubber roller is favoured by some. It is also of the litho type, and should be smooth and hard. Handled rightly, it is capable of inking up the most delicate work quite as well or even better than a "nap" roller, and it is also a good substitute for a glazed roller, if care be taken not to overheat the plate. A hard, well-seasoned composition roller on litho stock is also useful, especially for proving.

Of course, more slabs and more rollers will be required, according to the amount of work to be done and the number of hands working at the bench. It is advisable to have separate slabs for each kind of ink,

and covers for them, so that a good deal of time is saved which would otherwise be occupied in cleaning-up and in remixing inks. It is also good to have separate nap rollers for litho and etching inks.

An ink knife for taking the ink out of the tin, a palette knife for mixing, and a push knife for scraping the slab are requisites; and a little bridge of wood should be nailed to the bench to rest the blades on when covered with ink, so that they will not daub the bench. These articles have already been illustrated on a preceding page.

A couple of basins and sponges should be provided near each ink slab, one for water and the other for gum solution. Damping rags of meat cloth or cheese cloth are also required.

For retouching the plates before or in the course of etching a hand-rest is useful. This is simply a strip of thin wood, say 3in. by 18in., with a batten at each end underneath, so that it bridges over the plate without touching the surface.

Each etcher is usually provided with a fine sable brush, and a square steel point set in a cedar handle like a lead pencil, which he calls a "scratcher." With these two tools he does all his clearing up and retouching. For line work and vignettes a slip of snakestone is also useful to make any large erasures.

Near the stove is usually placed a shelf so arranged that the plates can be leaned against the wall and the back and margins painted with a resist varnish, generally of shellac, applied with a camel-hair mop.

The fine etcher's bench, which of late years has become of much greater importance than the rolling-up bench, is provided with sloping desks to support the plate, and each man should have a little easel to support the original picture in front of him. Some firms put all originals into a frame with glass in front, so that they do not get injured by unclean hands.

A good assortment of fine sable brushes and saucers for ink and stopping out varnish are requisite. Also a stiff plate brush to clean out any grit from between the dots.

Etching needles, burnishers, roulettes, and gravers are also used by the fine etcher, if, as is frequently the case, he combines the duties of fine etcher and engraver-retoucher.

Etching needles are square, lozenge, round, and oval steel points set in wooden handles, pre-

Fig. 79.

senting the appearance shown in fig. 79. The fine points are used for taking out any black spots between the dots, and for scratching white lines as guides for borders. The square, lozenge, and oval points are used for scraping in vignetting operations.

Fig. 80.

Burnishers are made in a great variety of shapes, either all of steel, as fig. 80, or with wooden handles, as fig. 81. The steel blade is highly burnished, and of

course must be carefully protected from rust. They should be wrapped up in washleather when out of use. When a light part of the half-tone grain is rubbed with a burnisher it prints darker, and thus any over-etching or want of contrast can be remedied.

Fig. 81.

Roulettes (fig. 82) have the opposite property to the burnishers. They lighten any parts which would print too dark by stippling the places required with fine holes which print as white dots. There are a great variety of roulettes made, some only with one row of dots, like a spur, and others with a number of rows. They are also in varying degrees of fineness corresponding to the grades of the half-tone screen. Roulettes are also made with lines instead of dots on them, the edge of the wheel being "milled" like the edge of a coin. These are mostly used for breaking up heavy line work, but

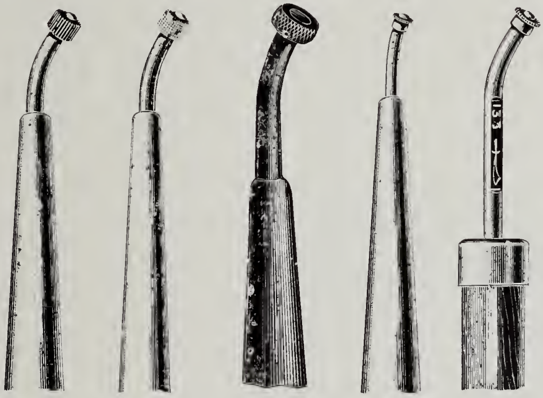


Fig. 82.

they can also be used to advantage in half-tone vignetting to run round the edge and soften the work.

A great variety of gravers (fig. 83) are used where the plates are elaborately retouched by the engraver. These gravers are much the same as used by wood engravers, but are of a different temper, and set to a different angle. Rubin, of Paris, makes the finest gravers in the world. Vautier, a Swiss maker, runs him very closely in reputation. There are also gravers of Sheffield manufacture, which are very good for heavy metal work. A peculiar class of gravers which are much used by process men are known as "many liners." They are, as their name implies, gravers which cut many lines at one operation, having a serrated cutting edge. They are very useful in vignetting to break up the hard edge of the work which would otherwise print very heavy.

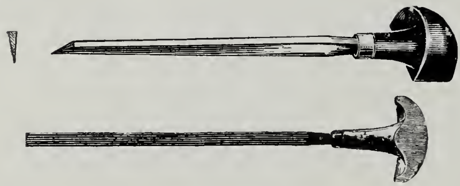


Fig. 83.

The fine etchers and engravers require hand magnifiers to be able to see their work, and it is very

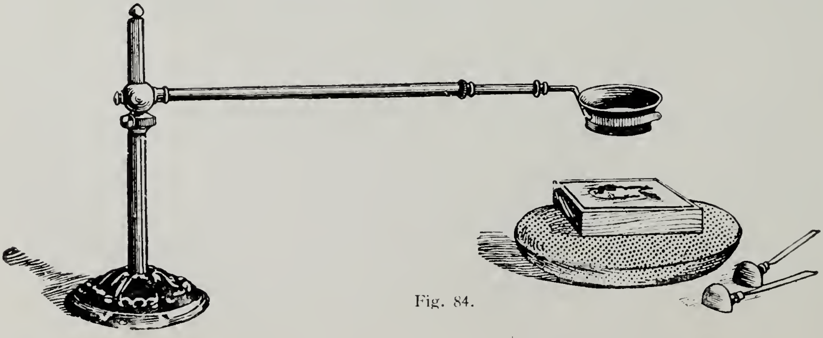


Fig. 84.

convenient to have the magnifiers supported on a stand with swinging telescopic arm, as fig. 84.

When working by artificial light, a bull's-eye lens, or a water-globe lens (figs. 85 and 86), must be provided to focus the light of the lamp on to the plate.

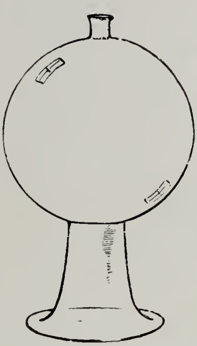


Fig. 85.

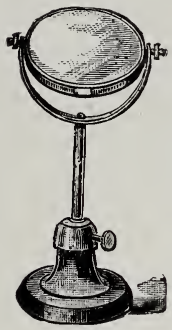


Fig. 86.

The ruling of border lines, and the writing or engraving of the imprint name in the corner of the plate, are usually done on the fine etcher's bench.

A useful appliance for aiding the ruling of the border lines is the ruling board (fig. 87).

This is a well-clamped board with a slot running diagonally across it, and a raised strip of brass on two sides of the board, thus forming a right angle, in which the plate lies and is held by a clamp which runs in the diagonal slot. A **T** square with an adjustable head is used in connection with this board. If the picture is not quite parallel on the plate the **T** square is set to any perpendicular object. The head of the square being screwed up and pushed against the outside edge of the right angle

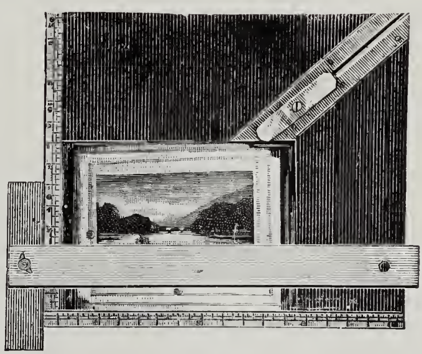


Fig. 87.

brass strip in which the plate is held, it is obvious that the T square must rule parallel lines at top and bottom and each side of the picture, forming perfectly right-angled corners, without the necessity of measuring or trying with a set square.

If the ruling board is not used, a right-angled steel set square, L shape, with both sides of equal thickness, is used, one line being struck and the others successively ruled from it. Set squares of 45° of steel, ebonite, or transparent celluloid are also used for the purpose.

For ruling circles or elliptical border lines, either

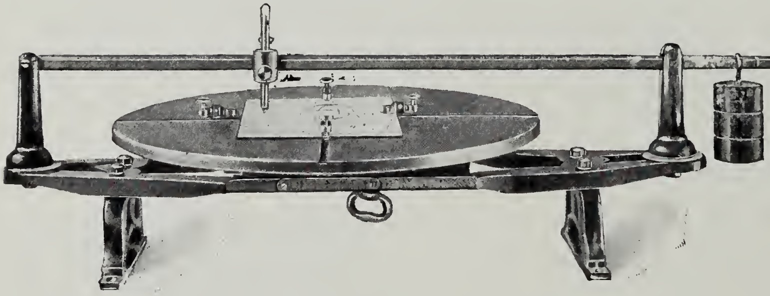


Fig. 88.

brass shapes are used as guides for the ruling pen, or an elliptograph (fig. 88) is employed. The latter is a highly ingenious and useful little machine, which will rule any size of circle or oval most perfectly. It is provided with a ruling pen for ink, and a graver to cut white lines. Most of the large photo-engraving houses have these machines, which soon repay their cost where there is any considerable amount of work.

To ensure neatness in lettering the name, line gauges

are used. These are small blades of steel, something like a short length of watch spring, notched at the end to form two or three points, as the case may require, and these blades are set in brass holders about the length and thickness of a retouching brush. When these gauges are run along a straight edge they make two or three fine parallel scratches on the surface ruled upon. Lettering drawn upon these lines can be made with the letters of even height. A three-line gauge is used for capitals and small letters, and a two-line gauge for capitals only. There are a dozen different gauges in a set of each kind.

The best way, however, of lettering a block is to use a stamping press, as fig. 89. The name is cut on a steel die, and inserted in the plunger, which is adjusted to stamp only to the requisite depth, or it may be made to

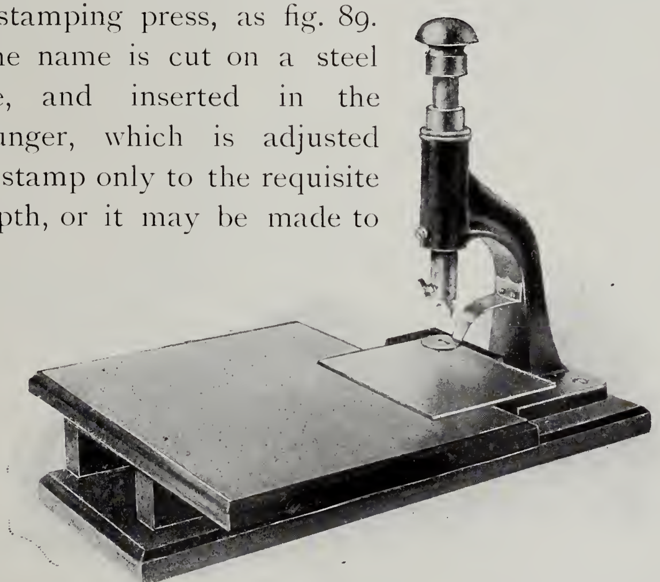


Fig. 89.

mark only sufficient to guide the pen and brush in making black lettering.

In some of the large establishments an engraver's ruling machine has been added to the equipment of the fine etching and engraving department. By its means skies and backgrounds can be cut in perfectly parallel and regular lines across the half-tone grain, so that the plate prints lighter in these portions.

The author has also seen used for outlining the vignetting preliminary to routing an electric pen or drill, which consists of a flexible shaft driven by a small motor, and carrying at the end a rose-shaped "bit" in a holder somewhat like a fountain pen. A channel is

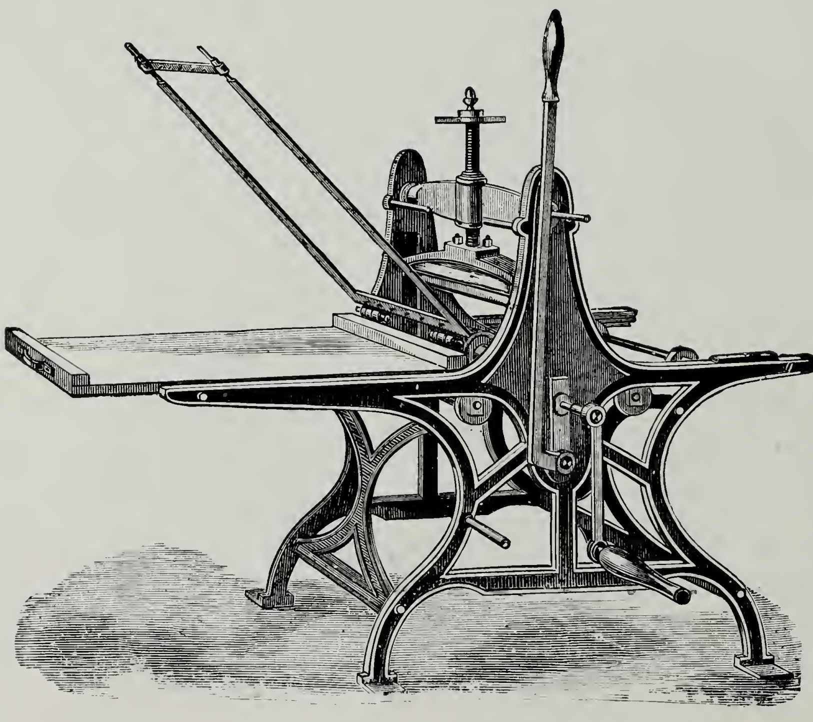


Fig. 90.

scraped away, rendering the course of the vignetting easy to follow with the routing machine.

If there is space to spare, it is desirable to have a press in the etching room for taking proofs from the plates when operations are completed. It is much better that the etcher should be able to see the effect of his work as soon as etched, so that any faults may be remedied before it leaves his hands. A litho press (fig. 90) will do very well for taking proofs from plates, and as it is much cheaper than a type press, it may on the whole be recommended.

Respecting the lighting arrangements, the long window or row of windows will furnish a good light by day, and a gas bracket with universal joint, and a shade over each etching trough, each rolling-up slab, and each fine etcher's or engraver's desk, will be requisite. If the luxury of incandescent electric light is provided, as may readily be done where there is an electrical installation for the studio, so much the better. The windows should not be made to open at the bottom, as this may drive in a lot of dust on the ink slabs and on work in hand. The hot plate will probably provide all the warmth required in the winter time, and it will be best if it can be made to do so, as a coal or coke stove will certainly generate dust, the arch enemy of the half-tone process. The hot plate may be supplemented by a gas-heating stove if necessary.

CHAPTER VIII.

THE MOUNTING AND PROOFING.

THE author feels some difficulty in giving instructions for the equipment of the mounting room, because circumstances will determine whether the mounting will be done entirely by hand work or by means of power machinery.

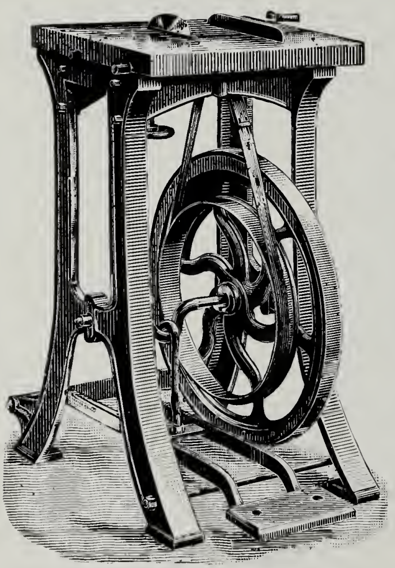


Fig. 91.

In a small establishment where there is not much work and no necessity for "rush," a treadle circular saw, a jig saw, and a shoot and bevel plane outfit will be all the machinery required, though it may be supplemented with advantage by a guillotine, which will presently be described.

The treadle saw will be of such a pattern as fig. 91, and it will serve for cutting up zinc and copper, and mounting wood. Separate saws for metal and wood are desirable. The difference between the two saws is that the wood saw has fewer and larger teeth, and is of

larger diameter, than the metal saw, the teeth being also "set" rather strongly to give clearance for the blade. The metal saw is generally of a thicker gauge, smaller diameter, less "set," and more teeth (therefore finer teeth). A wood saw will probably have not more than four to six teeth to the inch of circumference, whilst a metal saw will have eight to ten. The smaller the diameter and the finer the teeth in a metal saw the better. The circular saw is not only used for straight sawing, but a good deal of trimming may be done on it in the case of vignetted or shaped blocks.

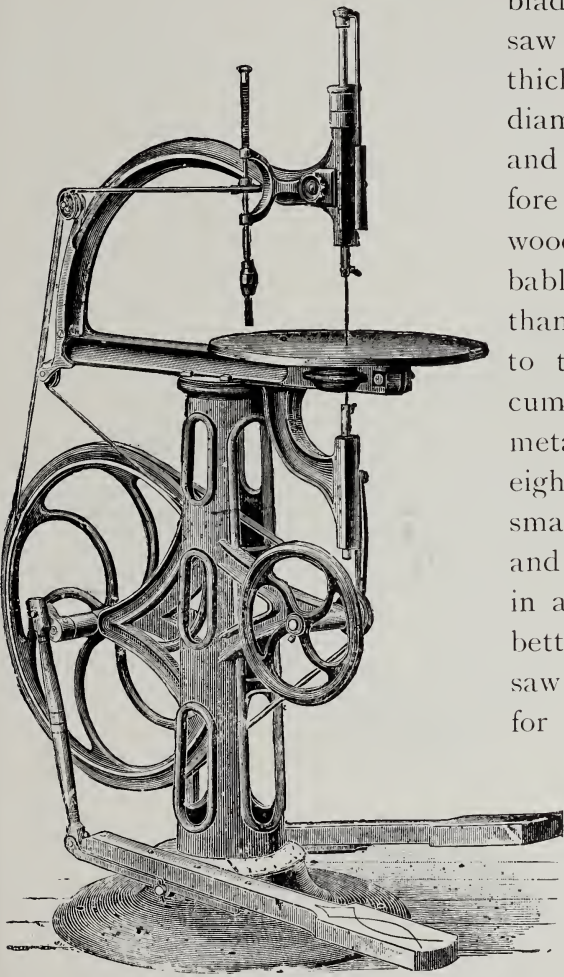


Fig. 92

For cutting out spaces in the interior of a picture the jig saw (fig. 92) is used, as well as for difficult places—

round, shaped, and vignetted blocks. The jig saw is, however, a machine which is least needed, as we have already pointed out that the circular saw will do a great part of its work, whilst a hand fret saw will do the interior spaces, or, better still, the routing machine where available.

The shoot plane is an indispensable tool in small establishments where a beveller and trimmer is not warranted. Fig. 93 shows the usual form. It consists of an iron bed-plate with a channel at the side, in which

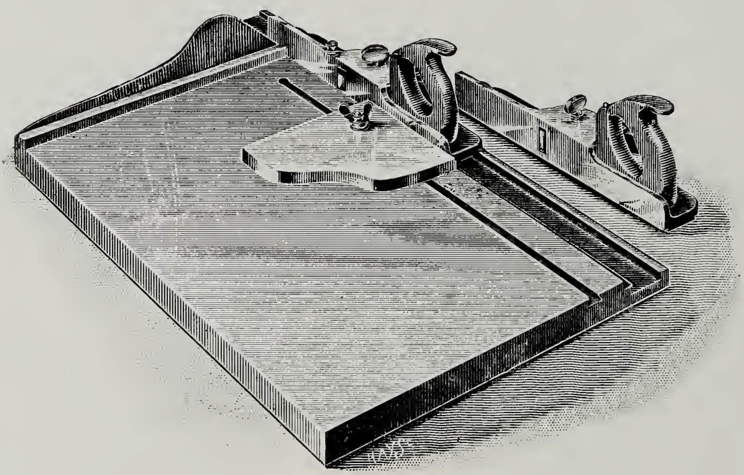


Fig. 93.

an iron plane works to and fro. One plane is provided for trimming the edges of the wood blocks, and the other for bevelling the edges of the plates, so as to permit the nail heads to lie below the surface.

It is really very important to make a good bevel on the plate. A half-tone block which prints with a smeared outline and with several nail heads showing up

is probably a good block spoilt by bad mounting Many attempts have been made to dispense with the rebate, by filing or cutting the edge flush and by gluing the plate on to the wood, and by soldering small brass screws on to the back of the plate ; but the best and neatest way, after all, is to cut a bevelled rebate. This can only be done by use of a suitable plane. The requirement in such a plane is plenty of weight, and for this reason, and also because of the wear and tear, it is generally made of cast iron, with a planed face, in which a narrow groove is cut, corresponding to the rebate, and with its under side level with the top of the board. The cutting iron is set in this groove, and as the cut is made, the tongue of the rebate gradually passes under the cutter into the groove. The cutter is sharpened on the side as well as the end, and the angle of grinding is very important, and can only be found by actual practice. A second plane is usually supplied for squaring the wood mounts.

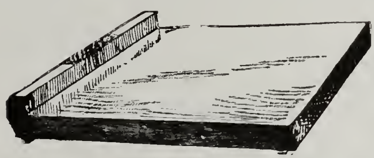


Fig 94.

Whether the mounting room is provided with power machinery or not, a good bench must be provided for the "blocking," and this should be well lighted by windows, and by gas brackets or electric lamps at night. On this bench the shoot plane outfit will be placed, and in another part the blocking plate (fig. 94). This is an iron block about one inch thick, provided with a stop at one end to keep one side of the plate on the wood

mount whilst being nailed on, the base giving the necessary solidity when hammering and punching in the nails.

A similar block made of lead is used in addition, or sometimes instead of the above. It is used for punching the nail holes in the zinc plates with a sharp punch, this method being quicker than drilling if the plates are thin. It is well to have a hand drill also, in order to countersink the holes. The lead block serves for hammering on in driving in the nails, and also for chipping upon, when no router is available. Chipping tools are enlarged engraving tools, but are either provided with a handle like a carpenter's chisel, and are to be used with a mallet, or have a solid shank, and are used with a broad, flat-ended hammer.

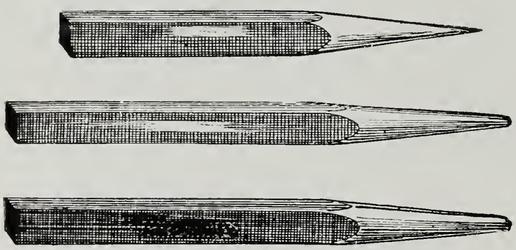


Fig. 95.

Three punches are required (fig. 95). One is sharp and highly tempered for punching the holes; one with a flat end about $\frac{1}{16}$th diameter, for driving home the nails; and one with a broader head, about $\frac{1}{8}$th inch, which is termed a vignetting punch.

Another useful form of punch is one with a rectangular end about 1in. x $\frac{1}{8}$in., this being used for straightening out a bevel if bent during the nailing on the block, or through having to remove the plate and replace it.

There is always a risk when driving a nail that the punch may slip and damage the work, and Penrose and Co. have introduced a neat little tool (fig. 96) for overcoming this difficulty. It is a hollow tube with punch inside. The tube is slipped over the nail, the punch acting as a plunger driven with a hammer.

Three hammers of 4 oz., 8 oz., and 16 oz. weight of head will be necessary—the first a carpenter's hammer, and the last two engineers' hammers. A light mallet is required for use with the chisels.

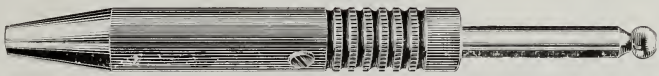


Fig. 96

A 36in. steel straight-edge, a good steel or boxwood rule, a carpenter's square, a steel try square, a pair of steel dividers, and one or two metal files are among the requisites. A dozen assorted engraver's scrapers are useful for removing burrs on nail holes, bevels, and routed edges.

Mounting wood can be bought ready planed to the exact gauge, so that it is no use bothering one's self with planes and boards for backing the blocks. In a large establishment, as we shall presently show, it is profitable to have a rotary planing machine. A hand saw for cross cutting long planks of mounting wood to suitable lengths is necessary.

It will be the duty of the mounter, as a rule, to cut up the metal for the etchers, and this may be done on the circular saw, or by means of the guillotine

(fig. 97). The circular saw has the advantage that a corner can be cut out of a large plate, whilst the guillotine must cut through the whole width. However, the guillotine makes a clean cut, whilst the saw cut has to be filed. By cutting up to sizes found by experience to be most useful the guillotine can be utilised to the best advantage.

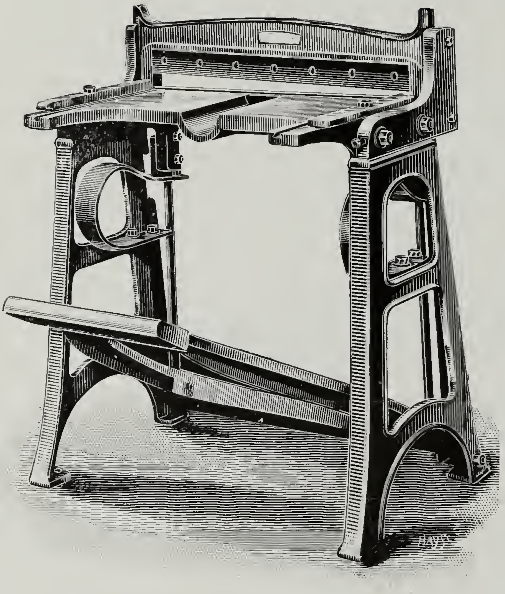


Fig 97

Workers in a small way may cut up zinc with a tool known as a zinc hook (fig. 98). A deep score, guided by a straight-edge, is made in the zinc, which is then snapped against the edge of the bench. A zinc cutting board with permanent straight-edge can be obtained in the form illustrated (fig. 99).

Turning now to the question of power machinery, which has now become one of the most important considerations in the successful running of commercial establishments, the choice of a suitable location must be first dealt with.

Fig 98.

The mounting is often associated with the etching room in small establishments, but this is not to be

advised, as the sawdust and chips of zinc and copper get into the ink or the dusting powders, or are embedded in the rollers, causing trouble. Apart from this, the noise of the machinery, if a full line of machines is run by power, is distracting to the etchers, whilst the vibration makes it difficult for the fine etchers and retouching engravers to do delicate work.

If it is not possible to have a separate room a place at least ought to be partitioned off from the etching room, and, if power machinery is run, it should be as far away as possible from the studio, owing to the vibration caused.

Plenty of daylight is required for the manipulation of the machines, especially the router and the beveller. Electric lamps are also generally fitted on or above the machines.

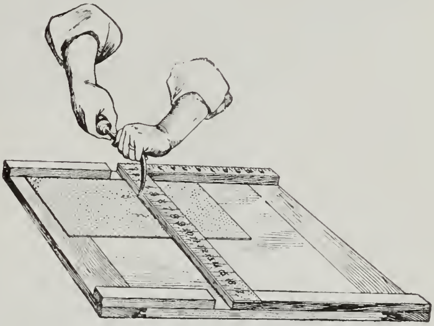


Fig. 99.

The floor should be a very solid one, and if a ground floor is used it is much better to put down a cement foundation, if it does not already exist. The machines will work quite well on upper floors, but the vibration will cause the cutting to be not so smooth, and the cutters will be blunted sooner, besides the machines wearing more rapidly.

A good ceiling for fixing countershafting is an advantage; but it is, as a rule, possible to fix it to the floor, if space permits, or to the wall.

Where the luxury of a separate electric motor for each machine can be afforded all countershafting is dispensed with, and the machines can be placed anywhere that suits best.

The power for driving machinery is invariably the electric motor, unless power shafting is already running in the place. Even then it is generally an advantage to have a motor, as this renders the photo-engraving department independent, and able to run when the rest of the establishment is shut down. About 2 h.p. to 3 h.p. will run all the machines likely to be required in a photo-engraving establishment, and each separate machine can be run by a motor of from ½ h.p. to 1 h.p. It is becoming quite a common practice now to have an independent motor for each machine.

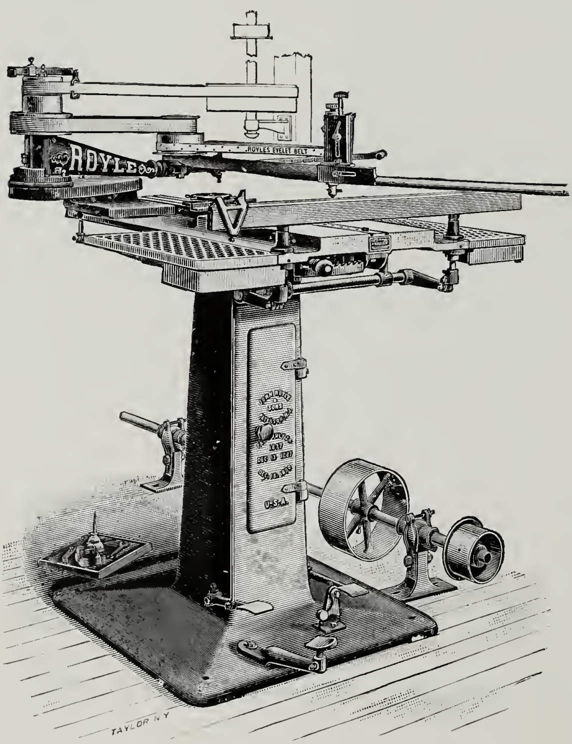


Fig. 100.

Continuous current motors are the most satisfactory wherever this current can be obtained, as they will stand a temporary overload better than alternating current motors.

All the machines being run at a comparatively high speed, the shafting should be light and free running, with good lubrication, well-balanced pulleys, and very flexible belting with neatly-made joints.

The most important machine is the router, the purpose of which is to rout or hollow out portions of the plate which are to be left white in the finished proof. This is requisite in vignetted and shaped blocks, and especially in blocks for catalogue illustration.

The router (fig. 100) is made in a variety of forms, but one principle is common to all, viz., that a drill-like cutter is revolved at a high rate of speed whilst in contact with the plates, cutting out the metal in circles running one into the other as the cutter or the work is moved about. The machines may be divided into two classes: (a) those in which the revolving cutter is in a stationary position, and (b) those in which the cutter is moved about on an arm having a radial movement, much in the same way as the movement of the pencil or tracer in a pantograph. Machines of the former class are usually of a limited size, and are used in small establishments, whilst those of the last-named class are used by large firms for handling all kinds of work.

The excellence of the machine chiefly lies in the perfect finish and fitting of the head containing the

bearing of the revolving spindle. When it is mentioned that this spindle has to be run at a speed of 14,000 to 15,000 revolutions per minute, the perfection of mechanical fitting requisite can be judged.

Royle & Sons, of Paterson, N.J., make the finest and greatest variety of routers, though their standard pattern is held by some workers to be rather light, and a heavier machine is often preferred.

European makers have not been successful in the manufacture of satisfactory routing machines for photo-engravers. The Royle radial arm router is probably the most popular and extensively used throughout the trade.

These machines, to be at all satisfactory, must be run by power. Treadle routing machines have been made, but have never become popular in the photo-engraving trade. It is true that brass plate engravers use treadle routing machines extensively; but it must be remembered that brass is an easier metal to cut than zinc or copper, and the work is fed up to the cutter by means of a screw motion. Special attention is also given to the shape of the cutter and its sharpening. Moreover, it is said that it takes at least a year to train a youth to work a brass engraver's router with any degree of satisfaction.

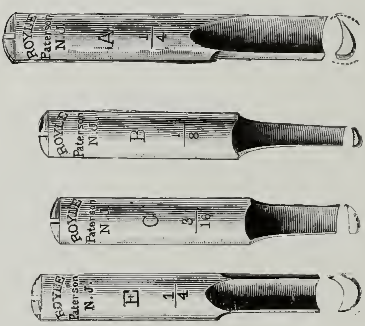


Fig. 101.

EXAMPLE OF WORK
DONE ON ROYLE'S
LINING BEVELLER.

EXAMPLES OF WORK
DONE ON ROYLE'S
LINING BEVELLER.

The author's opinion is that if power cannot be obtained to run a router it is better not to use the router at all, relying on the etching bath and the chipping chisels to deepen the work. The forms of cutters used in routing machines are shown herewith (fig. 101).

"A" is used for wood, soft metal, zinc, etc.
"B" for hard zinc.
"C" for soft brass.
"E" for cutting copper.

The cutters are only ground on the ends to sharpen. A handle is used to hold them against the grindstone They are finally finished with a rub on the oilstone. The shape of the cutter must not be altered, and those who attempt to sharpen a cutter should compare it with a new one.

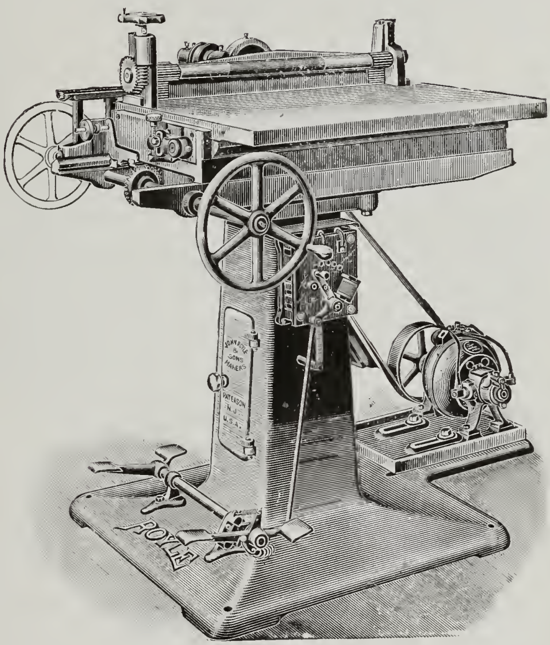


Fig. 102.

In the majority of American photo-engraving houses, and also in many in England and on the Continent, a rotary beveller (fig. 102) is used. Where a considerable amount of work is

to be done, it is a very useful appliance. The plate is clamped to a bed and fed to a guide until the revolving cutter, which is like a lathe chuck, with two or more tools set on its circumference, is opposite the part to be bevelled. The bed is then pushed forward under the cutter, and a furrow is made. It will be seen that it is not necessary to trim and

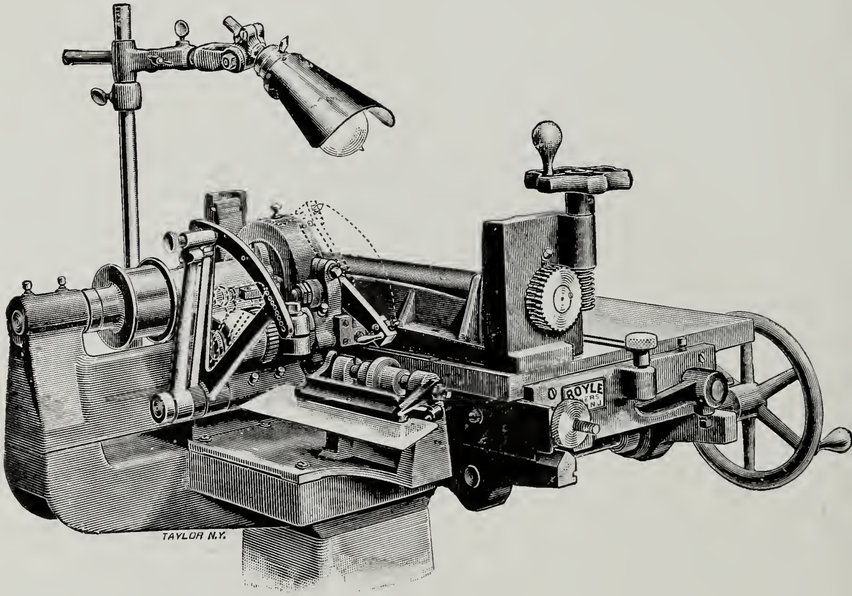


Fig. 103.

square the plate first, and the waste margin can be left on until the proof is pulled, acting as a bearer against the tendency of the impression to be too strong at the edges of the picture. Afterwards the margins can be snapped off by bending with the fingers.

Recently the beveller has been elaborated by the addition of attachments for making the black and white

border lines round the plates. Hitherto these lines have been put on by scratching through the negative film, or ruling with "resist" ink on the plate before etching, or by scratching or engraving the lines on the plate before or after etching. The lining beveller (fig. 103) performs these operations on the plate even after etching, if the machine is of the type known as the "raised line" beveller. The way in which the machine makes a black line on an etched plate is very ingenious, although it is a method long practised with hand tools by electrotypers. A small cutter called a "lance" is used, and its object is to cut a line with a very heavy burr thrown up at the sides. This burr is then shaved off by a chisel-shaped graver to the level of the printing surface, and the result is a black line. If a white line is desired inside the black line, a chisel which has a projecting graver edge to it is used, and makes a cut alongside the black line. If more than one white line is desired, the tool can be stepped forward, or the table can be moved to and fro by means of a micrometer adjustment. Some of the machines carry two or three

Fig. 104.

gravers of different patterns on a revolving head, so that they may be brought into position successively, and avoid changing tools.

Another labour-saving machine is a trimmer (fig. 104). It may be simply described as a rotary shoot plane, its object being to trim the ends of the wood mounts quite smooth and square, after they have been roughly sawn off. The block is placed on a sliding table, and pushed past the cutter head, which is provided with two or more cutters, and revolves at a speed of about 4,000 per minute. In using this machine there is a tendency, unless the knives are well set, to "jag" the under edge of the wood. This can be avoided by placing under the block a thin sheet of lead, and taking a cut off that at the same time.

Although mounting wood can be bought ready planed to gauge, it is found an economy in large establishments to have a planing machine (fig. 105), and prepare the wood on the premises. The planing machine is in the form of a horizontal disc, with two cutters set in its underside, and the wood is clamped to a travelling bed, which automatically passes under the cutter disc. The usual practice is to plane up short

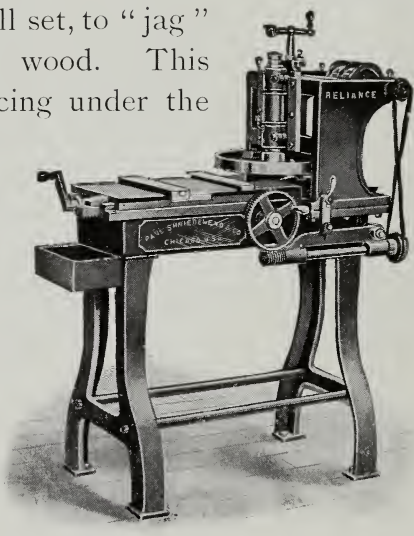


Fig. 105.

lengths from 18in. to 2ft., somewhat above the proper height. The mounter pins his plate on to a corner of one of these lengths, saws off the piece close to the plate, and puts the blocks on the bed of the planer with the cut face downwards. The cutters are set by means of an adjusting screw to plane exactly type height, and the block is therefore sure to be accurate and parallel. The sides are next squared up on the trimmer.

The foregoing comprise all the machines that can be usefully employed by the photo-engraver. Sometimes a power-drilling machine is used in large establishments, and the circular saw is often duplicated so as to keep one machine for metal and the other for wood. Two different types of routers or bevellers may be used where there is a large volume of work, but in general one or two good mounters can keep pace with half-a-dozen or more operators and etchers.

The proof-pulling department hardly warrants a separate chapter, for although it performs an important part of the work upon which a good deal of the commercial success of the firm depends, the appliances used are few and comparatively simple. As the operations follow, and are so closely in touch with, those of the mounting room, this chapter may fitly include all there is to say on the subject.

It is desirable that the proofer should be provided with a room, or partitioned off enclosure, apart from the other departments, as it is very essential that his ink and paper should be kept clean. He should have a good light, a fair amount of space, and a solid floor.

Formerly it was customary to use ordinary printers' hand presses, such as the "Albion" and "Columbian" in England, and the "Franklin" and "Washington" in America, for the work of proof-pulling, but it was soon found that these presses were by no means strong enough to withstand the enormous pressure necessary for obtaining a good black pull from a half-tone block. These presses always seemed to pull hollow in the centre of the block—that is to say, whilst the pressure would be too heavy at the margins, the centre would be grey. In attempting to apply increased pressure many presses were broken across the pillars or in other weak portions.

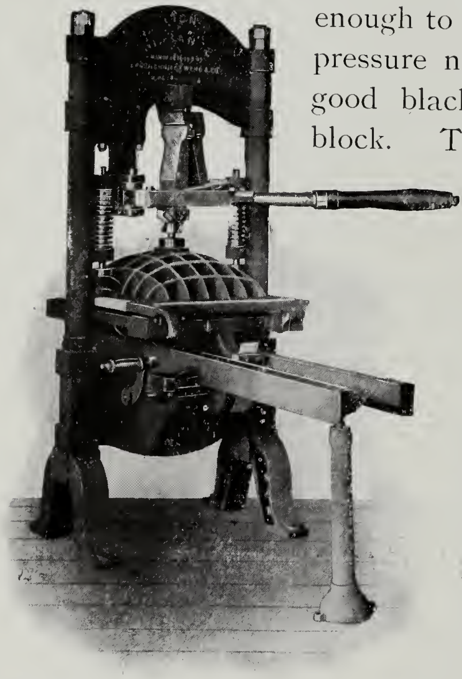


Fig. 106.

These difficulties led to the introduction of presses specially designed for the requirements of photo-engravers, and of these the "Reliance" is typical (fig. 106). Its feature is that an enormous mass of metal is built up towards the centre of the platen, and also underneath the bed. The strain of the pressure is taken by heavy steel rods running through the side columns, and the impression is applied by a well-

designed system of leverage applied to a toggle joint, so that one man is able to exert an enormous pressure. It is claimed for these presses that the full printing surface is available instead of about half the area, as was the case with the older forms of presses.

A useful, in fact almost indispensable, accessory to the press is a carefully planed cast-iron block upon which to lay unmounted plates. This block is the same height as a piece of mounting wood, so that it brings the etched plate to type height.

Fig. 107.

For colour work registering gauges can be obtained. These have the appearance of fig. 107, and the paper is fed up against the little projections on the steel blades placed near the margins of the block. If the second and third blocks of the three-colour set are placed in the same position, and the gauges left undisturbed, the sheet should register accurately, provided only that the plate is square on the mount and of identical size with its two companions.

An iron ink table, or a wooden bench with a litho stone on it, is required for the ink distribution.

The rollers are of the letterpress kind (fig. 108), as a rule of glue composition, but some men prefer the lithographic stock coated with the same composition. Separate rollers and slabs should be kept for colour work, and if possible a separate roller and slab for each colour, for obvious reasons.

A paper knife for cutting up the proof paper, a pair of long shears for trimming off margins, a pair of small scissors for cutting out large overlays, and an overlay knife for cutting out intricate overlays (usually provided for the use of the proofer), as well as a set of ink knives, a turps or benzine can (so arranged that drops can be shaken out without removing the stopper), about complete the modest requirements of the proofer. A good bench on which to lay out his paper and proofs should be provided alongside the press, and it should have drawers in it, trays for paper and for blocks, and a cupboard for the rollers and inks, if the very best accommodation is desired.

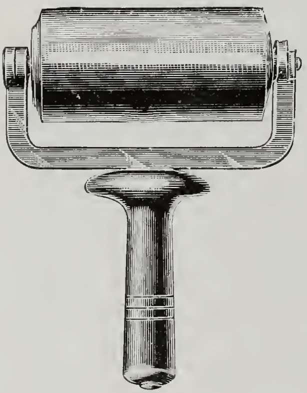


Fig. 108.

In large establishments it has become quite a common practice to add a platen power press, such as those known as the "Colt" and "Phœnix," which are both typical and very popular types of this class of machine. Orders for printing from the blocks are undertaken, the assumption being that the customer will have confi-

dence in the photo-engraver getting the best possible result from the blocks. Moreover, the photo-engraver has the opportunity of running off his own specimens. But probably the chief reason that has led to the introduction of these machines into the photo-engraving establishment is that it is believed they are better adapted for the proofing of three-colour work than hand presses, owing to the automatic inking features and registering apparatus. Some photo-engraving firms have gone still further, and introduced stop cylinder or two-revolution presses for dealing with three-colour work, on the ground that the blocks were so inadequately printed by the average letterpress printer. The great improvement in the handling of half-tone and three-colour blocks of late years by the printing trade, however, has removed the necessity for photo-engravers stepping outside their proper sphere of work.

CHAPTER IX.

THE MATERIALS USED.

IN order that the working instructions for the processes may be kept as concise as possible, and unbroken by the interposition of descriptions of the materials employed, the author considers it the best plan to devote a separate chapter to this subject, so that the worker may be familiarised with the articles before he proceeds to handle them, and also enabled to see what is required when commencing business.

Silver Nitrate.—This important chemical is used for the preparation of the sensitising bath in the wet collodion process. It is prepared by dissolving pure silver in nitric acid, but can be easily obtained commercially in large flaky crystals. Pure silver nitrate undergoes no change when exposed to light, but if organic matter be present a black deposit is produced. The recrystallised silver nitrate should be used, and should be soluble in its own weight of water. Zinc, iron, lead, tin, and other metals precipitate metallic silver from solutions of silver nitrate, hence the reason for using great care in preventing foreign substances coming into contact with the bath. The solution is usually made up to the strength of thirty-five or forty grains per ounce; it should never be

allowed to fall below thirty grains per ounce, and it is considered fifty grains per ounce is the maximum density at which a silver bath can be worked, even this being too strong. The specific gravity of a silver bath solution at thirty-five grains per ounce is 1·069 and at forty grains 1·078. Consequently, as already pointed out in a previous chapter, specific gravity bulbs, graduated for either of these figures, can be employed for the purpose of keeping the solution up to uniform strength. When boiled down to half the volume of solution the specific gravity will be 1·116, assuming it is boiled down to a density of sixty grains per ounce, 1·135 at seventy grains per ounce, and 1.153 at eighty grains per ounce. It must be borne in mind that these densities are for a pure solution of silver nitrate at 60° Fahr. For every 10° below 60° deduct one grain, and for every 10° above 60° add one grain. An old bath solution containing ether, alcohol, and iodides would not give a strictly correct indication, but it will be sufficient for the practical purposes of the boiling-down operation. There is no advantage in using "fused" silver nitrate but the double or triple recrystallised kind, if it can be obtained, is of the greatest purity. It is no disadvantage for the silver to give a slightly acid reaction when made up, as the bath will in any case have to be acidified.

Collodion.—Mawson's collodion has become a standard article in this country, and very few workers care to make up their own collodion. The commercial

collodion is usually sold with separate iodiser, so that the operator can iodise when required, and, if necessary, vary the proportions. Collodion is made by dissolving cotton, which has been treated with a mixture of nitric and sulphuric acids, in ether and alcohol. The nitrated cotton can be purchased ready prepared under the name of pyroxyline or gun-cotton. The quality of the collodion depends almost entirely on the kind of pyroxyline used, and it is necessary that anyone attempting to make collodion should be thoroughly familiar with the peculiarities of pyroxyline.* The proportion of ether and alcohol to be used will depend on the place in which it is to be worked. For cold climatic conditions the alcohol to ether may be as 4 : 5, whilst in summer the proportions will be equal. A good formula for the manufacture of process collodion is given in the "Instructions." Instead of using pyroxyline and risking its uncertainties, celloidin is to be recommended. It is sold in dry, flaky chips, and will keep indefinitely (although sometimes losing in weight). The chips are dissolved by first soaking in the alcohol, and then adding the ether. Any approved formula for iodiser may be used, and it is usual to keep back a portion of the alcohol for dissolving the iodides before adding to the collodion. For the purpose of stripping the films from the glass a special collodion is prepared, in which castor oil is introduced to render the film flexible.

*Those who desire to make collodion, or to understand the chemical principles involved, should study Hardwich's "Photographic Chemistry" and Abney's "Instructions in Photography."

Indiarubber Solution.—To ensure the collodion film holding on the glass, it is usual to paint the margin with indiarubber solution. This consists of the purest Para rubber cut into shreds and dissolved in benzole to the consistency of collodion. The rubber edging dries quickly, and serves equally as well as the albumen substratum, without any of the disadvantages of the latter, such as picking up dust and contaminating the bath. Indiarubber solution is also used for stripping films. The negative is first flowed with rubber solution, and when this is dry, flowed again with the stripping collodion already described.

The other chemicals for the wet plate or other negative making process need no special description. They are standard commercial chemicals, and it is only necessary to order them correctly by the names given in the formula from a reliable dealer who is familiar with the purposes for which they are required.

Albumen.—The albumen used in photo-engraving processes is egg albumen. This may be obtained from the whites of fresh eggs, or the dried egg albumen may be used. The latter is to be recommended, because eggs vary so much in size; to state that the whites of so many eggs are to be taken would therefore be very inexact. Moreover, eggs vary in their degree of freshness, so that results would be in some cases doubtful. By using dried egg albumen, which differs from the albumen from eggs only in the fact that it is denuded of water, greater uniformity of results is assured. It should be purchased in the powdered, not crystalline,

form, as the latter is troublesome to dissolve. The powder is of a whitish yellow nature, and as it is easily adulterated it should be obtained from a reliable dealer who knows the purpose for which it is required. The question is frequently asked: What proportion of dried albumen corresponds to the white of an egg? It is obviously one upon which no very exact answer can be given; but it has been stated that fresh eggs contain eighty-six per cent. of water. From this it may be deduced that fourteen parts by weight of dried albumen to eighty-six parts by weight of water will equal the density of fresh egg albumen. This will work out at about one dram albumen to one ounce of water, and for all practical purposes it will be near enough to use one dram of dried albumen where one egg is specified. The dried egg albumen is added to the water and beaten up with an egg whisk in the same way as the white of egg. Albumen is used as a substratum for collodion negatives; for mixing with fish glue in the enamel process; and by itself in combination with a bichromate in the sensitised coating for printing line negatives, as well as half-tone negatives in some processes.

Fish Glue.—As there is only one make of this article, there is not any chance of going wrong in this respect. There are, however, several varieties of fish glue, and it is necessary to say that the kind most suitable is labelled "Le Page's Photo-engraver's Clarified Glue." This form is cleared of all gritty sediment, and though it is thinner, and therefore does not go quite so far as

the "ordinary" kind, it is cheapest in the end. There are some few workers who still cling to the "ordinary" fish glue, labelled "F20," but it requires a lot of filtering, and often develops oily spots on the plate. Fish glue is supposed to be extracted from fish skins, etc., and it is rendered permanently liquid, either by long boiling or chemical treatment. The preservative added to make it keep is believed to be oil of winter-green. The glue should be practically free from acid for photo-engraver's purposes; it is not always uniform in quality, and appears to be affected by atmospheric changes, sometimes washing away too freely when developed, and at other times leaving an insoluble scum on the plate. The worker must get to know the peculiarities of the glue, and be ready to correct any differences, either by varying the proportions of the other ingredients of his solution or by altering the exposure.

Bichromates.—The bichromate salts are a very important consideration to the process printer, as they form the sensitive compound which enables him to print the photographic image on to the metal. For processes in which the film has to be inked prior to development, potassium bichromate has to be used, whilst for the fish glue enamel process ammonium bichromate is always employed. The former salt is the most stable of the two, but is not quite so sensitive as the latter. Both are obtained in bright orange crystals, the ammonium salt being the darker of the two. Sodium bichromate is also obtainable, but little used,

being a deliquescent and somewhat uncertain salt. The action of the bichromate is to cause the albumen or fish glue or gelatine with which it is mixed to become insoluble in the parts exposed to light. Thus a film exposed under a negative will have certain parts hardened, whilst the other parts corresponding to the white portions of the picture will wash away when treated with water. Whether the potassium, ammonium, or the sodium salt, the action is the same, and the worker who should unexpectedly run short of one salt can easily resort to the other. The chemical action depends on the reduction of the chromic acid in the bichromate to a lower state of oxidation, hence it is usual to add chromic acid to the fish glue solution to hasten the action, the effect of the chromic acid being to toughen the film and make it hold better on the metal.

Nitric Acid.—It is not necessary that this should be pure for etching zinc. The commercial variety is good enough. It is sold by weight, and by the carboy or half-carboy, weighing respectively about 112 lbs. and 56 lbs. The carboys should not be tightly stoppered, as they are liable to explode in hot weather, if the gases generated cannot escape. The acid may be tested by means of a Beaumé hydrometer, and should register about 44°. The test is not always a conclusive one, as sulphuric acid, which is cheaper than nitric, is often added to increase the density. The acid gives off brown fumes at full strength, which are very injurious to health. Nitric acid is always diluted for etching purposes.

Perchloride of Iron.—This is sold on the market in large yellow rock-like lumps, which rapidly become darkened and moist by exposure to the atmosphere. It should be kept in stone jars, and is dissolved by adding water. Roughly speaking, a pint of water to a pound of perchloride makes a solution of the strength necessary for etching, but the solution is always measured by floating in it a Beaumé hydrometer, which should register 35° to 40°. The solution should be kept up to this strength by adding more of the solid, or of a saturated solution.

Powdered Alum is used for making up an etching bath with nitric acid for the purpose of matting the surface of zinc plates (technically called the "passing bath"). This is the ammonia alum, as usually supplied for photographic purposes.

Chrome Alum is sometimes added to the etching bath, its object being to harden the film, this chemical having a hardening action on gelatine, glue, etc.

Chromic Acid is recommended in some enamel formulæ, to increase sensitiveness and make the film hold better on the metal by hardening the glue acted on by light. The chromic acid should be pure, in fine, needle-like purple crystals, not the red efflorescent variety used for electric batteries.

Inks.—Although the practice of making the sensitive film itself resist the etching has practically made the use of inks obsolete in half-tone work, there are occasions when the worker must resort to them, and it is desirable that he should be familiar with their properties.

Photo-transfer or transfer etching ink is a fatty, waxy compound, composed of such substances as wax, stearine, mutton fat, and lithographic printing ink. Thinned down with rectified turpentine, it is applied in a thin coating to a printed film of albumen bichromate, or to the gelatine film of photo-lithographic transfer paper after exposure. *Lithographic ink* is used to reinforce the transfer ink image. It consists of lamp-black, boiled linseed oil, and fatty matter, and is thinned down for use with lithographic varnish (boiled linseed oil). "Starting" ink follows the lithographic ink, building up a stronger resist. It is compounded of lithographic and thin letterpress printer's ink mixed with resin, asphaltum, beeswax, and other similar ingredients, melted together. This ink is also thinned down with lithographic varnish. *Finishing ink* has much the same ingredients as "starting" ink, but the resin, asphaltum, and beeswax are in excess, so as to make a very hard ink; it is thinned down with turpentine. *Proving ink* is simply a good letterpress printing ink, of much higher quality than ordinarily used by printers, being stifler and richer in depth of colour; it should not be thinned down with any varnish or other medium, but if difficult to distribute a little ink of a thinner consistency is mixed with it. *Lithographic writing ink*, used for the purpose of ruling border lines or retouching on the plates, writing in imprints, etc.; this ink is sold in sticks wrapped in tinfoil, and a little of the latter is peeled off at the end, so as to expose the ink, which is rubbed on the side of a warm saucer

containing a little distilled or rain water (ordinary tap water curdles the soap in the ink). This ink is used with a fine brush or a lithographic pen, and in the ruling pen. Liquid lithographic writing ink is sold, but is not considered so satisfactory, the ink being required of a good consistency, so that it may be sticky enough when warmed to attract a resinous powder brushed over it to increase its resistive properties.

Etching Powders.—Under this heading we have to consider resin or colophony, asphaltum, dragon's blood, and one or two specially made up powders. *Resin.*—The finest consists of the light yellow variety, and the same is heated to drive off volatile constituents, then ground very finely in a special mill arranged with a blower arrangement to keep the resin separated in fine particles, the tendency being to clog together. The powder must be sufficiently fine to go through a 120-hole sieve, or even finer. It must be kept in a cool, dry place in a tin or stone jar. *Asphaltum.*—For dusting purposes a bitumen rich in pitchy matter is best, and when finely ground it has a brown, snuff-like appearance. It is a better resist than resin, and never really melts, only softening and combining with the ink. By itself it would be useless as an acid resist, as it would be granular on the plate. When strongly heated it holds very tenaciously to the plate. Good combinations can be made by mixing beeswax with asphaltum, as is done for photo-lithographic purposes, and by mixing pitch, resin, and asphaltum, which form an exceedingly strong resist. *Dragon's Blood.*—The red

powder bearing this peculiar name is a very powerful resist, and one of the most valuable of all etching powders. It is a resin extracted from a tree in the East Indies. When powdered, it has a rich, dark crimson colour. It is soluble in alcohol, but not in turpentine or benzole. After being brushed on the plate, so that it adheres to the ink, it is heated until it becomes a deep chocolate brown. As the powder is useless when adulterated with resin or with earthy compounds, as it too frequently is when bought at a low price, care should be taken to see that it is of the best quality. A little placed on a strip of paper and a light applied to it will melt and run together with a bright black surface if pure.

Acid Resist Varnishes.—*Shellac varnish* is generally used for coating the back and margins of the plates for the purpose of preventing their being etched. It is simply made by dissolving shellac in alcohol (methylated spirit). *Stopping-out varnish* is also a shellac varnish, but thickened with other ingredients, and mixed with a strong aniline black. It is thinned by means of methylated spirit. Asphaltum dissolved in turpentine alone, or with a little benzole, is often used as a stopping-out varnish. Better still is Brunswick black, which is much the same thing, but has finely ground lamp-black mixed in with it. Bates's black makes a good stopping-out varnish. Some workers stop-out with finishing ink thinned down with turpentine.

Zinc.—Formerly most of the etching, both in line

and half-tone, was done on zinc, which, owing to its cheapness and adaptability to the processes, was found to be the most suitable metal for the work. Although copper has largely superseded zinc for half-tone work, the latter metal still remains supreme for line work, and is also largely used for photo-lithography. The quality of the zinc used in the etching processes is an important factor in their rapid and successful working. The best zinc for etching purposes is mined in Asturia (Spain) but is prepared in France. The Belgian zinc, of the Vielle Montagne, is a good zinc, but often uneven in quality. When good it is hard, and etches evenly. The Silesian zinc is pure, but very soft; it is more usually adopted for line work, owing to the rapidity and smoothness with which it is etched with nitric acid. English zinc, mined in Wales and Cornwall, is generally too full of impurities to be used for photo-engraving. American zinc seldom finds its way into Europe; it is exceedingly hard, brittle, and not very pure, being accordingly difficult to etch. The heating necessary for burning-in the enamel in the half-tone process renders zinc soft, crystalline, and brittle, hence it is generally only used in processes where there is no excessive heating. The etching of zinc is invariably done with nitric acid, and, as a rule, the surface is matted before applying the sensitive coating. The zinc, as purchased for photo-engraving, is flattened, planished, and highly polished. It would not pay to polish the metal one's self. The polishing is done by machinery fitted with rapidly revolving brushes charged

with whiting and oil. There are two kinds of polish, one known as "straight," in which the polishing marks run in straight lines from end to end of the plate; and the other known as "round," the polishing marks forming small circles all over the plate. It is generally considered that the "round" possesses the highest polish and flatness, and is the best for half-tone.

Copper.—This is by far the most used metal for the half-tone process. Its use became necessary on the introduction of the enamel process about 1892-93. Copper will stand almost unlimited heating up to the melting point without deterioration, and it etches very smoothly and rapidly with perchloride of iron in solution. The best and cheapest copper comes from America, and is largely imported into Europe, the purest being that manufactured by electrolytic processes. The American copper is somewhat softer than that manufactured in Europe. Good, hard copper comes from France and Germany, and high-class copper is prepared in England for photogravure purposes, but is very expensive. It is hammered, planished, and polished by hand, whilst the American and Continental copper is generally rolled and machine polished. American copper when etched has a clean pink tinge, whilst European coppers usually have a dark scum formed in etching. The American copper is invariably "straight" polished, and has not a very high polish. This is considered an advantage—in fact, American workers generally polish their copper with charcoal before applying the sensitive coating. European copper is usually "round" polished and of

high finish; it is, as a rule, used with its original surface, the greasiness being first removed.

Brass.—Although this metal is cheaper than copper, and possesses many of its advantages, it is not extensively used, owing to its not very uniform etching quality. Nor is it so easy to cut and bevel as copper and zinc. Brass is etched with perchloride of iron. Good brass for etching comes from Germany.

The thicknesses of plates used in photo engraving, whether zinc, copper, or brass, as measured by the Birmingham wire gauge, are 14, 15, or 16, though, as a rule, 15 is ignored, and 14 is used principally for line work; 16 gauge being the accepted thickness for half-tone plates. Copper is almost without exception used in 16 gauge for half-tone work.

Steel.—For intaglio printing, steel plates have been used of late, the image being put down on them by the enamel process from a positive, and the plates etched with perchloride of iron or with various special etching fluids which each firm holds as a secret. For power presses the plates are about $\frac{1}{4}$in. thick, and have to be hardened before printing. The exact method of hardening is not known outside the establishments using the processes, but it is a difficult operation, requiring great care to avoid the plates being cracked or warped. Generally speaking, the process consists of heating the plate and then immersing it in water or some special solution, much in the same way as tools are hardened.

Mounting Wood.—For bringing up the metal plates to type height oak and mahogany are principally used

by English houses, but in America cherry, birch, and beech are used. The latter woods have nothing like the same durability as oak and mahogany, and they are more apt to warp and swell. Laminated wood has been introduced, consisting of several layers of the same or different woods glued together opposite ways of the grain. Mounting wood can be purchased ready planed to suit the gauge of the metal.

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G. S. LITTLEJOHN.

REPRODUCED BY THE BRITISH
PHOTO ENGRAVING CO., LTD.
COVENTRY.

PART II.

THE OPERATIONS.

CHAPTER X.

THE PHOTOGRAPHIC OPERATIONS.

BY common consent wet collodion holds the field for process negative making in commercial work, because it is believed to be cheaper to work, and the peculiar character of negatives desired can be obtained more easily by its means than by dry plates. It has been demonstrated over and over again, however, that suitable gelatine dry plates can be used, and give satisfactory results. The beginner or the worker in a small way of business will probably use dry plates, and therefore instructions for their use are appended. Collodion emulsion is also growing in favour, its use being stimulated by its great adaptability for three-colour negative making by reason of the ease with which it can be colour-sensitised. A well-made negative on collodion emulsion is in no way inferior to wet collodion, and the working is no more difficult, but the manipulations require greater care in regard to cleanliness and accuracy of making up the solutions.

Wet Collodion Process.

The Silver Bath.—The volume of solution to be made up will be proportionate to the dimensions of

the largest picture the camera will take. In case the dipping bath is used, the quantity can be determined by measuring water into it until filled. The horizontal bath will only require about half the quantity of solution that a dipping bath requires for a given size plate. We will presume that an 80-ounce bath is to be made up. The strength of silver required is 40 grains to the ounce. A simple multiplication sum shows us that 3,200 grains of silver nitrate are required (=7 ounces 2 drams $17\frac{1}{2}$ grains avoirdupois weight). We need not weigh it to half a grain; one scruple (= 20 grains) will be the nearest weight to put on the scales for the odd $17\frac{1}{2}$ grains. The silver should always be weighed on clean paper, an equal size piece of paper being placed in the opposite scale-pan. To prepare the bath, take 80 ounces of distilled water, and to a portion of this in a clean white glass bottle add the silver, shaking up till all is dissolved. Then add 15 grains of potassium or ammonium iodide (the proportion is about half a grain to every 100 grains of silver) dissolved in a little water. Instead of iodide a minim of iodised collodion to each ounce of bath solution may be added. Some operators simply collodionise a plate and let it remain in the bath about half an hour. Shake up thoroughly after iodising, add the remaining water, filter the whole, and add 30 minims of pure nitric acid. The solution, if now tested with blue litmus paper, should turn the latter slightly red. The funnel used for filtering the bath should always be kept for that purpose, and the bottle in which the solution

was mixed should likewise be reserved for emptying the bath into.

The Collodion.—The beginner will be well advised to buy a collodion of some well known make, but those who have had any experience in collodion manufacture may make up the following, which is a well tried formula:

Pyroxyline	... 120 grains	...	120 parts.
Sulphuric ether, sp. gr. ·720	... 5 fl. ounces		2,200 „
Alcohol, sp. gr. ·805... ...	... 5 „	...	2,200 „

To bromo-iodise above, take

Ammonium iodide	... 40 grains	...	40 parts.
Cadmium iodide	... 40 „	...	40 „
Cadmium bromide	... 20 „	...	20 „
Alcohol, sp. gr. ·810 to ·815	... 5 fl. ounces		2,200 „

After making the above solutions, mix, let the resulting solution stand for a week, and carefully decant off the clear solution into the pouring bottle for use.

A general rule to remember in modifying collodion formulæ is that to secure clean crisp negatives the bromide should be diminished. A quarter grain to each ounce of collodion is held to be sufficient to secure cleanness in the shadows. If a decrease of contrast and more detail be required, the bromide is increased. The proportion of bromide to the iodides should be one part of bromide to from three to five parts of iodides. In the above formula it will be seen that the proportion of bromide in the collodion is $1\frac{1}{4}$ grain per ounce, and of bromide to iodide is 1 : 4. When iodised collodion is of a pale straw colour it is in its most sensitive condition, and this may be produced by adding

a few drops of tincture of iodine to it. This addition of iodine is also conducive to bright images.

The Developer.—The iron developer is always used for wet collodion process negatives. The following is a suitable formula :

Iron protosulphate	20 grains ...	20 parts.
Glacial acetic acid	20 minims ...	20 ,,
Water	1 ounce ...	440 ,,
Alcohol	20 minims ...	20 ,,

It may be advisable to dilute the above to the extent of one-third its volume in working fine screens.

In some formulæ copper sulphate to the extent of half the quantity of the iron is added, and is believed to give increased density.

Abney recommends as much as 30 grains of iron to the ounce for general purposes. Eder gives 15 grains of iron to the ounce for half-tone negatives. It is certainly an advantage to keep up the strength of the iron solution when working by electric light. A weak developer tends to deposit silver on the parts not strongly acted upon by light, whilst keeping down the density where it is required.

The object of the acetic acid is to prevent the too rapid deposition of the silver, which but for the presence of the acid would take place all over the film. The acid is added in just sufficient quantity to regulate the reduction of the silver. The proportion given in the formula is a very good one. It may be useful to mention that nitric, sulphuric, and citric acid serve the same purpose, and may be used in the emergency of running short of supplies.

The object in having alcohol in the developer is to make it flow over the plate. A film sensitised in an old bath repels an aqueous developer, which consequently flows in a greasy, streaky manner over the plate, but the addition of alcohol overcomes this tendency. After the bath has been used about a week it will be necessary to add another ounce of alcohol to the developer; and the older the bath becomes the more alcohol will be required, up to four ounces in each pint of developer. With a new bath no alcohol is needed. Methylated spirit is often used for the purpose, but it is best to use spirits of wine owing to the impurity of the former.

The Fixing Solution.—Potassium cyanide is invariably used for fixing, but sodium hyposulphite can be used. It is believed, however, that the cyanide is easier to wash out, gives a brighter image, and does not cause the film to split on drying as is sometimes the case with hypo. There is no definite standard of strength for the cyanide solution, because as a matter of fact the cyanide itself varies in strength between thirty per cent. to ninety-eight per cent. The former is generally used for photographic purposes, and for this the following formula will hold good:

Potassium cyanide ...	25 grains ...	25 parts.
Water	1 ounce ...	440 ,,

A little in excess of the quantity stated is of no consequence.

Re-development.—Either before or after fixing, the density may be built up by re-development with an

ordinary iron developer without alcohol in it, or with either of the following formulæ :

No. 1.

Pyrogallic acid	2 grains	...	2 parts.
Citric acid ...	2 to 4 ,,	...	2 to 4 ,,
Water	1 ounce	...	440 ,,

No. 2.

Ferrous sulphate	5 grains	...	5 parts.
Citric acid	10 ,,	...	10 ,,
Water	1 ounce	...	440 ,,

No. 3.

Hydroquinone	5 grains	...	5 parts.
Citric acid	3 ,,	...	3 ,,
Water	1 ounce	...	440 ,,

No. 1 brings up density more quickly than No. 2, but requires a correctly exposed negative on which to work. No. 3 has latterly become very popular on the Continent.

Whichever re-developer be used, a few drops of silver nitrate solution (ten grains to the ounce) must be added immediately before applying it to the negative.

Intensification.—After the image is fixed, it is usual to apply the following solution to change the metallic silver to a state of iodide :

Iodine, resublimed ...	1 grain	...	1 part.
Potassium iodide ...	2 grains	...	2 parts.
Water	1 ounce	...	440 ,,

After this solution has been applied to the film, any of the following intensifiers may be applied :

A	Copper sulphate ...	50 grains	...	50 parts.
	Water	1 ounce	...	440 ,,
B	Potassium bromide ...	30 grains	...	30 ,,
	Water	1 ounce	...	440 ,,

Mix A and B together, and flow over the image until it is bleached a creamy white. After washing under a good stream of water, apply the following:

Silver nitrate	100 grains ...	100 parts.
Water, *distilled*	1 ounce ...	440 ,,

A dense black image should be produced. It is usual to follow with

Ammonium sulphide ...	80 minims ...	80 parts.
Water	1 ounce ...	440 ,,

This gives intense blackness, but a drawback to its use is the objectionable smell of the liquid ammonium sulphide. Sodium sulphide, which is in crystals, may be substituted with advantage. The formula will be:

Sodium sulphide	10 grains ...	10 parts.
Water	1 ounce ...	440 ,,

Another intensifier, which gives great blackness and is invariably used for line work, is the lead intensifier:

Lead nitrate	20 grains ...	20 parts.
Potassium ferricyanide ...	30 ,, ...	30 ,,
Water	1 ounce ...	440 ,,

About five minims of acetic acid may be added to promote clearness. The plate is immersed in this solution until it becomes an opaque yellow colour. It is washed and rinsed with dilute nitric acid (about three to five minims of commercial nitric acid to the ounce of water) until the transparent parts are free from any deposit on them. Then the plate is blackened with ammonium or sodium sulphide solution as described above.

The mercury intensifier can also be used, but does not give such great density, and requires rather more care. The formula for it is:

Mercury bichloride ...	20 grains ...	20 parts.
Ammonium chloride ...	20 „ ...	20 „
Water	1 ounce ...	440 „

The negative after being well washed and fixed is immersed in the above until bleached white, after which it is further well washed. Blackening is usually done with ammonia (one drachm to one ounce of water), but greater blackness may be obtained with ammonium or sodium sulphide.

"*Cutting*" *Solution.*—It is usual to employ a reducing solution for the purpose of "cutting" (as it is termed) the dots. The effect is to clear away any deposit between the dots and also cut off any ragged fringe at the edge of the dots, leaving them absolutely sharp and black. This cutting usually follows the intensification and subsequent washing. Iodine solution, the formula for which has already been given, is at this stage flowed over the negative until a green or blue sheen appears in the shadows. The plate is then rinsed, and the following solution of potassium cyanide poured over at one even flow:

Potassium cyanide ...	3 grains ...	3 parts.
Water	1 ounce ...	440 „

Instead of using the cyanide separately, it may be mixed with the iodine solution. In this case the cyanide solution is added to the iodine solution drop by drop until the deep sherry colour of the latter disappears and the solution is transparent.

After the application of the cyanide, or cyanide and iodine combined, the plate must be quickly rinsed and examined with a fairly powerful magnifier to see if the

dots are correct. If insufficiently treated the solution is re-applied.

A solution of ferricyanide and of sodium hyposulphite as used in the dry plate process may also be used for "cutting."

It is usual to apply the blackening solution of sulphide after the cutting.

To get great density it has been recommended to intensify first with copper bromide, then cut and re-intensify with lead, finally blackening with sulphide.

Varnishing.—When the copper bromide intensifier is used, there is sometimes a chemical action set up when the negative is in contact with the metal plate, causing the silver of the image to stick to the bichromated film and pull away from the collodion. To avoid this the negative should be floated with a dilute solution of gum arabic whilst wet, or with a solution of albumen, viz.:

Albumen, dried ...	... 60 grains	...	60 parts.
Water	... I ounce	...	440 ,,

Glass Cleaning.—Glass plates when new are soaked in nitric, sulphuric, or hydrochloric acid, rinsed, and smeared with a whiting on both sides, then stood in a rack to dry, after which they are wiped with a clean rag and well polished with a chamois leather. Any grease or dirt is thus taken up by the whiting and polished off. Tripoli powder, made into a paste with methylated spirit and a little ammonia, is also sometimes used. If the polishing is perfect and the plate breathed upon, the condensed breath will leave it in an

even manner. Films are removed from old negatives by soaking in strong nitric, sulphuric, or hydrochloric acid, after which the plates are polished as described.

Stripping Films for Reversal.—In America especially it is the practice to strip the negative film from the original glass and to transfer it with a number of others to one large glass, so that all may be printed and etched at one time. When films have to be stripped, the glass plates should not be albumenised. They should be simply well cleaned and polished and edged with rubber to make the film adhere at the edges. After the negative has been finished and dried off it is flowed with rubber solution, which consists of pure Para sheet rubber cut into shreds and dissolved in benzole to the consistency of collodion. When the benzole has evaporated from the film the plate is flowed again with "stripping" collodion, for which the following is a good formula:

Alcohol ...	... ... $\frac{1}{2}$ ounce	...	220 parts.
Ether ...	... ... $\frac{1}{2}$,,	...	220 ,,
Gun cotton	... ... 10 grains	...	10 ,,
Castor oil	... ... 7 ,,	...	7 ,,

Collodion Emulsion.

Collodion emulsion dry plates have been found well suited for half-tone work, but unfortunately there are none on the market, and the operator must resort to the operation of making his own plates, which will be as troublesome as working the wet plate process.

Ready-made collodion emulsion, which has simply to be spread on the plate and can be exposed wet or dry, can be bought in some places. Dr. E. Albert's collodion

emulsion is typical and well-known on the Continent, where it is extensively used. It has also been introduced in England, and is rapidly gaining favour. The emulsion itself would be very slow but for the sensitising dyes which are added to it. These dyes appear to be eosine-silver compounds, which have the effect of greatly increasing the speed of the emulsion whilst at the same time making it orthochromatic. The sensitising dye for half-tone work is marked A, and it brings up the speed of the emulsion much higher than wet plate or even gelatine photomechanical plates. The plates are coated similarly to wet collodion, and after draining are placed, without washing and without being dried, into the dark slide for immediate exposure, keeping for about half-an-hour in the moist condition. The development is with a simple hydroquinone developer, and is very rapid. The fixing is quickly done with sodium hyposulphite or with potassium cyanide. Intensification for half-tone work is done with copper-bromide, nitrate of silver, and sulphide of sodium or of ammonium. Reducing or "cutting" is done with iodine and cyanide after the manner adopted with wet collodion. The films can also be stripped by the method already described for the latter process.

It does not seem necessary here to give the formulæ for development, etc., of this emulsion, as this information is supplied to purchasers of the emulsion. It can readily be seen that collodion emulsion has several advantages over wet collodion, chief amongst which is the abolition of the silver bath and the greater rapidity

of exposure. The development and other operations are quite as quick, and the plates can similarly be dried off with heat. The cost of the emulsion is about the same as the cost of iodised collodion, plus the silver used for making up the bath.

Those who prefer to make an emulsion will find the following, which is von Hubl's formula, very good:

Forty grammes (616 grains) of silver nitrate are dissolved in 50 ccm. (850 minims) of warm distilled water. Liq. ammonia ·880 sp. gr. is added drop by drop until a clear solution results. 100 ccm. ($3\frac{1}{2}$ ounces) of absolute alcohol are then added, and the solution left to cool. Thirty grammes (462 grains) of ammonium bromide in 35 ccm. (595 minims) of water and 70 ccm. ($2\frac{1}{2}$ ounces) of absolute alcohol, the solution being warmed. Now take 450 ccm. (16 fl. oz.) of four per cent. collodion in a glass flask of the capacity of one litre (one quart), and in the dark room the silver solution (cold) is added to the collodion. A part of the collodion separates out, but by vigorous shaking it is brought into solution again. A part of the silver salts also remains suspended in the solution in the form of fine crystals. The ammonium bromide solution in a warm state is added in three or four portions, well shaking between each. The solution is finally given a vigorous shaking for fully a minute. The emulsion is then precipitated by means of distilled water. It is now in a very powdery condition and is collected on a linen filter cloth and washed for some time. The cloth is then squeezed, and the water drained off. The emulsion is still moist with alcohol, and is now dissolved

in 800 to 1,000 ccm. (28 to 35 oz.) of an equal mixture of alcohol and ether. Codein is added to the extent of 0.5 gramme (8 grains) (as an organifier), and the emulsion is left for a day to ripen, and is then fit for use.

The glass plates are best given a substratum of gelatine or an edging of indiarubber. A substance called Gelacoll is supplied for the purpose and is very good. For small plates the emulsion may be thicker than for large ones, and the thinning can be done with the mixture of alcohol and ether. It is immaterial whether the plate is allowed to dry or is exposed wet. For development 25 grammes (1 ounce) of sodium sulphite are dissolved in 40 ccm. ($1\frac{1}{2}$ ounce) of warm water, and 50 grammes ($1\frac{1}{2}$ ounce) carbonate of potash added gradually in small quantities on account of the carbonic acid given off. This is kept as a stock solution, and when required for use is given a good shake up. 75 ccm. ($2\frac{1}{2}$ ounces) of the stock solution are taken for use and diluted with 12 to 15 ccm. (3 to 4 drams) of water. Plates exposed wet are first washed with distilled water and the developer flowed on. Dry plates do not need washing, and are developed in a dish. Sodium hyposulphite is used for fixing.

For intensification the plate is well washed after fixing, and then bleached with a concentrated solution of mercury bichloride. After a further good washing, blackening is done with the following solution:

A { 1,000 parts of distilled water.
 1 part of gold chloride.

B { 1,000 parts of distilled water.
 10 parts of sodium hyposulphite.

The two solutions A and B are mixed, and before

using the solution must be well stirred up, and a drop of ammonia added. Should the desired blackness not be attained at the first flowing, the operation should be repeated. The gold solution will keep for a long time if put away in the dark.

Gelatine Dry Plates.

Certain kinds of gelatine dry plates made especially for "process" can be used. Most dry plate-makers now make "process" dry plates, and as typical may be mentioned Mawson's "Photomechanical" (which is good for line work) and "Half-tone"; also Ilford "Process" and "Half-tone." The relative speeds compared with "ordinary plates are as follows:—

Mawson.		Ilford.	
Process	6	Process	8
Half-tone	2	Half-tone	2
Ordinary	I	Ordinary	I

An "ordinary" dry plate is probably twenty to twenty-four times more rapid than a wet collodion plate, and the difficulty of making good half-tone negatives will increase as more and more rapid plates are selected, owing to halation and similar causes tending to spread and blur the dot images. On the other hand, if a very slow plate is used there is a difficulty in bringing up dots in the shadows. On the whole it is certainly more difficult to make a good printable half-tone negative on a dry plate than on a wet collodion plate.

The common fault is that the transparent portions are veiled over before the necessary density can be obtained, and the high lights are closed up before the shadows have hardly been acted upon.

Experience has shown that to overcome these difficulties those developers must be selected which give very hard dense black images without staining or veiling.

It is practically impossible to give any standard formula for development of process dry plates, and it is best to follow the maker's instructions. Some of the modern developers, such as Glycin and Adurol, give exceptionally clean black images. Glycin especially has been used with success. Where alternative formulæ are given by the makers, hydroquinone is to be preferred to pyro, as the latter is very apt to give stained negatives which are difficult to print.

Care must be taken to use fresh solution, and especially clean hypo solution. Exposure must be full, even to the extent of over-exposure, as a slight veiling due to this cause may be cleared immediately after fixing, without fully washing in the following reducing solution :

Potassium ferricyanide ...	5 grains ...	5 parts.
Water	1 ounce ...	440 ,,

To effect reduction by this method it is necessary that there should be some hypo in the film. If the plate has been washed thoroughly it will be necessary to add some clean hypo solution to the ferricyanide solution, or to immerse the plate again in a clean fixing bath.

The writer considers that this application of the reducing solution is in all cases desirable in making half-tone negatives, not only because it clears the plate

from veil, but because it acts similarly to the reducing solution in the wet plate process, sharpening the edges of the dots, and reducing the size of the dots in the shadows. But to carry the reduction so far that the dots are reduced in size it is necessary that there should be a good joining up in the high lights. For cutting down the dots it is necessary that the ferricyanide solution should be much stronger than the above—in fact, a saturated solution—and a few drops of it should be added to a freshly prepared bath of hypo of the usual fixing strength. This should be poured on the negative with one clean sweep, so that it may act rapidly all over; then be poured off quickly, and the plate well rinsed under the tap. The dots can then be examined, and if not sufficiently acted upon the reducer is again applied.

Intensifiying is best done by the mercury formula with silver cyanide:

Mercury bichloride	12 grains	... 12 parts.
Ammonium chloride	12 ,,	... 12 ,,
Water	1 ounce	... 440 ,,

If after bleaching the negative is immersed in a solution of ammonium chloride, twenty grains (twenty parts) in one ounce (440 parts) of water, the washing which follows bleaching may be more quickly done. The blackener is:

Silver nitrate...	30 grains	... 30 parts.
Distilled water	1 ounce	... 440 ,,
Potassium cyanide	30 grains	... 30 ,,
Distilled water	3 ounces	...1,320 ,,

The silver nitrate is poured into the cyanide solution

whilst continuously stirring, and when mixed the plate is immersed. Washing follows. As in most cases negatives for half-tone work have not to be kept, it is unnecessary to give them a great amount of washing.

It is a good plan to back the plates with some anti-halation medium, of which there are a number on the market. It should be something which dries quickly and is easily washed off before development. It is also an advantage to heat the back of the plates on an electric radiator until they are as hot as the hand can conveniently bear. The backing is then applied and dries instantly, whilst the heating is said to have the effect of contributing to greater sharpness of dot.

Greater care, of course, must be taken in using dry plates than with wet plates to see that the camera is light-tight and the dark room light-safe.

CHAPTER XI.

MAKING THE NEGATIVE.

LEAVING the dark room for a while, let us get the camera ready, and endeavour to understand fully its manipulation in regard to the half-tone process. The worker must be presumed to have some photographic knowledge, and therefore it is unnecessary to explain minutely the principles of the lens and camera.

Preliminary Precautions.—Parallelism between the original and the various parts of the camera is the first essential. Next is to see that the lens, prism (or mirror), and ruled screen are quite clean and free from dust. Except the mirror, these should be polished with a very soft piece of silk (as an old silk handkerchief) or an old linen handkerchief, taking care that there is no grit in it or on the glass surfaces, as the highly polished glass used for the above pieces of apparatus is very susceptible to being scratched. Rouge, whiting, or similar substances should not be used. Instructions for polishing the mirror have already been given. If the inside of the camera is at all dusty, wipe it out with a damp chamois leather or sponge. The dark slide must also be dusted and wiped out, and a folded

strip of blotting paper laid on the bottom edge of the carrier to receive the drainings of silver solution from the plate. It is most important that these drainings should not be allowed to accumulate in the slide or on the bench, for the most perfect woodwork cannot withstand the action of the silver nitrate solution, which not only rots the wood and disintegrates the glue, but prevents even the wood which is only partially attacked from ever being glued together again. Further if the silver nitrate is allowed to dry in the slide it gives rise to a metallic dust which is absolutely fatal to collodion emulsion work, and may cause trouble with wet or dry plate processes. It is, indeed, a mark of intolerable slovenliness and carelessness to see a dark slide with the bottom rotted out by silver solution, when five minutes spent at the beginning and close of the day or a few seconds between the operations would avoid it.

Fixing up the Copy.—The "copy" (as the original picture to be reproduced is always called) is pinned up with drawing pins on the board. It should be fixed upside down, so that it will come right way on the ground-glass, which makes it easier to focus. The longest way of the "copy" should be set vertical to agree with the direction the plate is drained if the wet plate process is used. It is sometimes easier to illuminate large copies by placing the longer dimension horizontal, in which case it is easy, of course, to drain the plate in the horizontal instead of the usual vertical direction.

The Illumination.—The placing of the arc lamps is

very important, as it is difficult in some positions to avoid causing reflections from the surface of the copy, especially when the latter is of a glossy character. These reflections will lead the operator to suspect his camera, prism, lens, screen, collodion, bath, developing chemicals—in fact, everything but the right cause—when he gets veiled and unsharp negatives.

It is a little difficult to explain without resorting to a geometrical diagram how these reflections reach the plate and how they can be avoided; but if the operator will look upon his copy as a mirror he will readily see that he must place his lamps in such a position that if his eye were in the position of the lens he could not see their reflection in the mirror, and if they cannot be seen from the position of the lens it is obvious they will not be seen on the ground-glass.

The utmost light possible must be concentrated on the copy. The more intense the illumination the better will be the result. A copy exposed in a dull light, even if it is exposed proportionately longer, never renders so good a negative. To get the best effect of the light, it is well to spread a sheet of white paper on the bed of the copying stand just under the board; this will reflect the light upward, and prevent the grain of the paper of the original showing up if at all rough. Likewise, if one side is unequally lighted, it is advisable to put up paper reflectors.

The two lamps must be placed at equal distances from the centre of the copy and from the surface of the board. A slight difference in the distances makes

a great increase or diminution of the light, because of the rule that the intensity of light varies inversely as the square of the distance. For example: Twice the distance makes the intensity not twice but four times less; half the distance makes the intensity not twice as great but four times as great. It is most important that this principle should be fully grasped, in order that the operator may do rapid and successful work. He may more than halve his exposures by knowing the minimum distance he can place his lamps.

The intensity of the light may be still further increased by concentrating the rays on to the copy by means of a condenser. For small sizes a large reading glass may be used, and, in fact, it is the practice sometimes to concentrate the light by means of such a lens on the shadows of the picture during a portion of the exposure so as to help to bring up the shadow dots.

Focussing.—Focussing must be done carefully, and must be always done with the ruled screen in the camera and brought close up to the plate. The screen will darken the image on the ground-glass, and will make the focussing somewhat more difficult; but experience and the strong light of the arc lamps will soon make the operator forget this difficulty. The focussing should be done with full aperture, and if there is no sharp detail in the picture a bit of printed paper should be pinned up alongside it.

The older types of rapid rectilinear lenses were always focussed at the centre, and stopping down

resorted to in order to increase the circle of sharpness; but the modern anastigmat lenses, notably the Cooke Process Lens, require that an average sharpness over the whole plate be obtained, and the stop inserted to increase the general sharpness of the image, which may look a little hazy at full aperture.

A low power focussing eyepiece is an aid to sharp focussing, and is invariably used. The focussing screen may be rubbed with oil, all excess being wiped off until the screen is semi-transparent. A clear centre to the ground-glass, formed by cementing to it, by means of Canada balsam, a microscopic-cover glass, is also an useful aid to focussing, and a means of observing the dot effect formed by the screen.

Choice of Diaphragm —Let it be first understood that it is not possible to work with full aperture when using the ruled screen. If, when the lens is at open aperture, the operator applies the focussing eyepiece to the clear centre of the ground-glass and moves the ruled screen to and fro, he will see that at no position can he get a sharp image of the screen, and except when close up he cannot get any image of the screen at all. On diminishing the size of the diaphragm, however, it will be found that the image of the screen gets sharper and sharper until with the smallest diaphragm it is as sharp as the screen itself, even when the latter is a considerable distance away from the ground-glass. But it will also be found that as the screen image gains in sharpness the image of the copy loses in detail and contrast, and it is obvious

that the more we diminish the size of the diaphragm the more we shall increase our exposures. It appears to be necessary, then, to find the mean or average size of diaphragm that is best for the purpose. To determine this the operator must measure the distance between the diaphragm slot of the lens and the inner or ground surface of the ground glass. He must also know what is the ruling of his screen—that is to say, the number of lines per inch. Now the size of the diaphragm has a definite relation to the size of the screen opening (the mesh) and to the extension of the camera, measured as just described. Expressed in words it can be said :

(*a*) The larger the screen mesh the larger will be the diaphragm.
(*b*) Also : The greater the extension of the camera the larger may be the diaphragm used.
(*c*) And, again, the further the screen is placed from the plate the smaller must be the diaphragm.

Clearly, then, to work out any calculation we must determine what distance the screen is to be placed away from the sensitive plate. Suppose we say, as close as we can get it. This will be the thickness of the pieces of metal which prevent the screen from falling out of its holder, plus the thickness of the cover glass of the screen. Together these usually make about $\frac{1}{10}$in., which may be adopted as an easy figure for calculation.

Let x be the width of one side of the square stop, a be the width of the mesh of the screen, b the camera extension (distance of ground-glass from the stop), and c the distance of the ground-glass from the screen. Then, if the operator has not forgotten the "rule of three"

which he learnt at school, he can figure out the following easy little problem:

> Given that the camera extension is 20 inches. the screen 100 lines to the inch ($=\frac{1}{200}$in. mesh), and the minimum screen distance is $\frac{1}{10}$in., what will be the largest diaphragm that may be used?

From the data given—

$$a = \tfrac{1}{200}\text{in.}$$
$$b = 20 \text{ in.}$$
$$c = \tfrac{1}{10}\text{in.}$$
$$x = \text{the value to be found.}$$

and from the facts already stated we arrive at the equation

$$x = \frac{a \times b}{c} = \frac{\frac{1}{200} \times 20}{\frac{1}{10}} = 1\text{in.}$$

The average operator may find it troublesome to make this calculation every time, but fortunately he need not do so, as Penrose's Pocket Book on the Half-tone Process gives tables showing the maximum stop and screen distance for all the usual screens and camera extensions.

It is also possible by practice to determine what stop will suit by inserting the stop and examining the clear glass centre of the screen with a powerful focussing eyepiece, when the shape of the dots will be seen, and by experience the operator will know whether they will join up. With a square stop placed with its sides at 45° to the lines of the screen, the effect will be somewhat that of a chessboard; but the operator must remember that it is the white squares which are going to act on the sensitive plate, so that the black

squares must be isolated in order to produce joining up. The best way to get to know the effect is to set a screen distance and insert a diaphragm known by calculation or reference to the tables to be correct. Note well the effect through the eyepiece. Make a negative, with correct exposure, and see if the result is as desired. (The effect to be looked for will be subsequently described.) After repeating this a few times the operator will soon get to know what to look for, but the result will be misleading if the exposure is not correct.

Shape of the Diaphragm.—In ordinary photographic work none other than the round diaphragm aperture is considered, but in the half-tone process a great variety

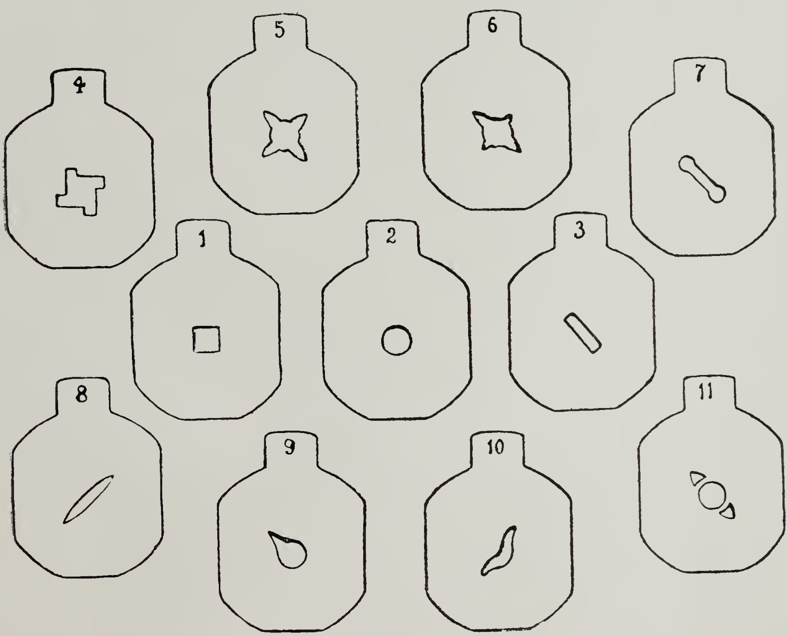


Fig. 109.

of shapes of aperture has been suggested from time to time by various workers. Fig. 109 (published by S. H. Horgan) will give an idea of the miscellaneous shapes which have been proposed and in many cases used, but as an outcome of experience there are practically only two general shapes which have to be considered, viz., the square and the square with corners extended. Both these are embodied in the Penrose diaphragm system, and if the underlying principle of these two stops is fully comprehended the action of all others will be quite readily grasped.

It may, in the first place, be put forward as a general principle that the shape of the dot will conform approximately to the shape of the stop used. For instance, if we insert a square diaphragm in the lens, we shall get a square dot. When the square stop is placed with its sides at 45° to the lines of the screen, as is usually done, the dot will not be quite square, but will be almost octagonal in shape, because the screen has cut off the corners. If, however, we extend the corners of the stop the dot will tend to spread at the corners, and will accordingly restore the parts which the screen has cut off. This spreading action is technically known as "joining-up," and the operator strives to obtain this effect in the high lights of the picture, until in the finished negative the dots actually overlap at the corners and form a chessboard pattern.

If the reader will turn back to Chapter I., he will find this action of the diaphragm explained on the

pinhole principle, each opening of the screen playing the part of a pinhole lens and photographing the shape of the diaphragm. Consequently it will be found that whatever the shape of the diaphragm, so will be approximately the shape of the dot—approximately, be it said, because the action is often disguised by other effects which it would be difficult to explain briefly here, and which in any case do not affect practical work.

Cross, star-shaped, and cushion-shaped stops are frequently used, all with the same object of promoting the joining up. Every operator appears to have his pet form of stop, and the beginner may be warned against trying every stop he sees or of which he hears, as it will lead him into everlasting muddle.

Standard shapes of stops suitable for half-tone work can now be obtained with lenses which are used for process work; but if the operator wishes to construct stops for himself he may do so out of black cardboard, cutting out the apertures with a sharp knife after the centres and external shape have been outlined from an existing round diaphragm. It is to be remembered that in order to cut a square diaphragm which shall have the same effective aperture as a round one, the diagonal of the square must be the same as the diameter of the circle.

Distance of the Screen.—From the considerations already stated it will be seen that the size of the stop and the screen distance are reversible values. It is quite possible to find a correct size of stop for every screen distance, or a correct screen distance for every

size of stop. We may use a constant screen distance and vary the size of the stop, or we may use a constant stop aperture and vary the screen distance. The latter is in practice impossible, because a constant stop would not suit every screen ruling, as we have shown that the screen mesh is one term in the equation when calculating the size of stop or screen distance. Further, we must vary the size of stop in order to keep the exposures fairly constant, the exposures varying with the distance of the sensitive plate from the lens. If we only varied the size of the stop we should require a large number of stops varying in size by a small amount, and it would be very difficult to estimate exposures. Hence it is found best to use few stops, and vary the screen distance to suit them.

The following rules apply:

1. The screen distance increases as the camera is extended, and decreases as it is closed up. In other words, lenses of short focus necessitate the screen being placed closer; and as the camera is focussed in for reductions the screen distance must be proportionately decreased.
2. Coarse screens allow of a larger distance from the screen, so do screens with thin black lines. Fine screens require closer distance; so do screens with thick black lines.
3. The larger the diaphragm opening the closer the screen must be placed to the sensitive plate. With smaller diaphragms it may be further away.

Remember that the greater the screen distance the more is the loss of light. It is in all cases preferable to use the largest possible aperture, and place the screen close for rendering the high-lights, but it will be necessary to give a part of the exposure with a small stop, as a large stop would fill up the high-lights before the shadows had time to act. The small stop has a good effect on the shadows, concentrating the light on the formation of a sharp and small black dot. In the ordinary course the separation of the screen and plate should be about $\frac{1}{32}$nd to $\frac{1}{16}$th or $\frac{1}{8}$th of an inch.

The operator must be warned against setting the screen distance too close and using too small stops, as this will give hard, screeny half-tones without roundness and gradation.

The Exposure.—If the exposure was made with one size diaphragm as in ordinary photography, the result would be that the high-lights of the negative would be fully exposed before the dot effect had time to form in the shadows, whilst the middle tones would be also incomplete. The usual practice is to force the formation of dots in the shadows by inserting a very small round diaphragm in the lens—say f/64 or even smaller—and covering up the copy with a sheet of white paper, which is sometimes moved about to prevent any image of creases or markings showing. The effect of this exposure is to form small isolated dots all over the negative. A square aperture of the duly calculated size is next inserted, and the normal exposure given—such an exposure as will form the picture. The duration

of this exposure will be about five times longer than it would be if the screen were taken away. With most subjects these two exposures will prove sufficient; but in the case of difficult copies—such, for instance, as are "flat" and wanting in brilliancy, having relatively dark high lights and light shadows—it may be necessary to give a supplementary exposure with the stop which has extended corners. This has the effect of joining up the high lights, without detriment to the other portions of the picture. It is impossible to give any ratio for these exposures, which must therefore be found by trial. The exposure for the shadow stop can be found by developing the plate after an exposure solely on white paper, whilst the sufficiency of joining up will very soon be observed in the ordinary course of work.

It is preferable to err on the side of slight over-exposure, as allowance must be made for the cutting down effect of the iodine-cyanide solution used for sharpening up the dots.

The Dark Room Operations.—The cleaning, edging, and collodionising of the plate, and the sensitising it in the silver bath, are elementary operations which need not be more particularly described. Those who are unacquainted with the wet plate process should read up some good handbook on the subject. The aim of these instructions is to explain only those operations which differ materially from the ordinary method of working.

Exceptional care must be taken to avoid dust spots and all abnormal markings on the plate, as these would

show at once in the finished half-tone. Everything should be at hand ready when the exposure is finished, as the plate will have a tendency to dry during these long exposures, and no time must be lost in getting it developed. The developing solution must be poured on in such a way that it will immediately flow over the whole plate without hesitation. Any marks caused by stoppage of the flow will be fatal to a half-tone negative. Nor must any solution be spilt from the plate, as we want all the silver we can get to build up the image.

If the exposure is correct, the picture will come up brilliantly in a very short time, and then will slightly dull all over. It is no good prolonging the development beyond this stage. Pour off the developer, and examine the negative with a powerful focussing magnifier by transmitted light. The point to determine is whether the dots in the high-lights are joined or nearly joined in a sort of chessboard effect. If they are very wide apart the negative is under-exposed, and it is useless going further with it. Assuming that they are right, give the negative a rinse, and immerse in the cyanide solution until cleared. If left in too long the image will be attacked.

Even if the plate has been intensified (re-developed) before fixing it will be necessary to intensify again after fixing. To do this wash the plate thoroughly in running water for at least five minutes. Then pour on the first intensifying solution until the image is bleached. Wash again thoroughly, and apply the blackening solution. Give the plate a rinse and again examine it with the

magnifier. If the dots in the high-lights are not quite joined up at the corners (fig. 6), continue the washing for about five minutes, and then apply the iodine solution again, and follow with the bleaching solution, wash, and repeat the blackening. The dots should now be joined unless it is a refractory case of under-exposure, or of the screen being placed too near. A third application of the intensifier may even be made, but before each subsequent application a weak solution of nitric acid must be applied and the plate washed In using the copper intensifier it is a good plan, for keeping the spaces between the dots clear, to flow over a weak cyanide solution after the blackening and washing. Then to wash again and to intensify again; rinse and flow with dilute nitric acid, and then apply ammonium or sodium sulphide solution. This gives an intensely black negative with clear glass spaces and sharply outlined dots.

The "cutting" solution is applied, as a rule, after the intensification, and before the final blackening with sulphide; it acts most vigorously on the edges of the dots, sharpening them up and making the negative such as will print better. It also reduces the size of the dots in the shadows, and thus secures a better gradation. In practice the action of the "cutting" solution is watched and stopped just at the stage where the dots in the deepest shadows have disappeared, and those in the next lighter shade are the merest "pin points." The dots of the other tones will graduate up in size until in the highest lights they join up firmly corner to corner.

If any break or want of density at the junction is shown, further intensification must be resorted to.

Between the extremes of openness and absolute closure, there are certain effects which are sought by some operators in order to accommodate the conditions of printing and etching. For instance, some etchers like what is termed a "fat" dot in the high-lights, which will gradually be reduced in the etching. Others like a cross-line effect—a slight junction of the dots on the metal—so that it holds back the etching. In the same way variations in the shadow dots are demanded. Some etchers prefer large dots, but we think the majority like best very fine dots, so that the white dots which they form will stand a slight enlargement in the etching. The character of the negative must also be suited to the thickness and sensitiveness of the film on the metal.

It will be best for the beginner to aim at the "chess-board" formation in the high-lights and "pin point" dot in the shadows. From this standard any desired variation can be made.

After the final washing the plate is dried off with gentle heat, if hurriedly required, and may be printed from without varnishing. But in the case of copper intensified negatives there is often a tendency for some chemical action to be set up between the film and the bichromate coating on the metal plate unless the negative is varnished. This varnishing is very simply done by flowing the plate over whilst wet with gum solution.

When dry the plate is ready for printing. Some

operators prefer to cut through the film a ruled border line to the picture, this being done with a sharp graver point pushed through the film with a cutting action, not dragged through the film, as the latter course would tear it.

Collodion Emulsion and Dry Plate Negatives.—All the conditions applying to wet plate negative making equally apply to collodion emulsion and especially the precaution as to dust spots, which seem particularly to affect a moist emulsion film worse than a wet collodion one.

It is thought by some operators that the screen distance and stop should be somewhat less in the case of emulsion plates, either collodion or gelatine, owing to the tendency of the dot image to spread in the film. It is certainly more difficult to get sharp dots in emulsion plates; but whether this is due to the spreading action or the difficulty of "cutting" to the same extent as wet collodion it is hard to say. Halation has something to do with it, and there is, therefore, an advantage in backing such plates.

Collodion emulsion negatives may be brought very near to wet plate quality as regards the dots, and they are superior in respect to gradation. The same cutting and intensifying must be resorted to. In the case of gelatine dry plates the exposure must be full to the extent of slight over-exposure, and the cutting done with ferricyanide solution. The best intensifier, in my opinion, for dry plate work is the cyanide of silver. The great difficulty in the case of dry plates is to keep

the shadow dots small enough. Some operators do not attempt to get them very small, relying on the closing-up effect of printing to produce the requisite effect.

One difficulty must be looked for in wet plate and moist emulsion, viz.. the accumulation of moisture on the screen due to dark room and studio being at a different temperature. This trouble is most frequent in the winter time. It may be overcome by rubbing a little glycerine or vaseline on the screen, and then polishing off; or by warming the screen slightly. But the best way is to endeavour to keep the dark room and studio at the same temperature. This will obviate many other troubles.

In the hot summer time the plate will have a tendency to dry during long exposures. Experienced wet plate operators will call to mind such remedies as adding glycerine to the bath, which may be done under proper conditions. The beginner is warned to avoid such a remedy, as it is more than likely that he will spoil his bath. A simple way to prevent drying is to affix a pad of damp blotting paper to the back of the negative.

It is well when working under a skylight which allows the sun to beat on to the camera to stretch a white cloth a little above the camera to reflect off the rays.

A good negative will have little contrast of the nature of ordinary negatives used for silver printing, that is to say, there will be no intense high lights and clear glass shadows when the negative is held at arm's length. There will be a dim slaty tint over the whole, no solid blacks being apparent, yet the picture showing the

detail quite plainly, especially when viewed against a sheet of white paper. Examined with a glass the dots should be intensely black. There should be no stain on the negative, nor veil between the dots.

A word may be said, in conclusion, with regard to the practice of making an allowance in the screen distance for the class of subject. Many operators do this, but I am not sure whether it is really warranted if the screen distance, stop, and exposure are correct in other respects. Generally speaking, the rules for distancing the screen in respect to subject are:

For light subjects, further away.
For dark subjects, nearer to.

It must be remembered, however, that light subjects reflect a greater amount of light than dark ones, consequently forming the dot image more quickly, whilst dark subjects have the reverse effect. The requisite variation, therefore, can be made by decreasing or increasing the normal exposure. In my opinion the screen distance and size of diaphragm aperture are conditions which are only affected by the relative focus of the camera and ruling of the screen.

CHAPTER XII.

PRINTING FROM THE NEGATIVE.

ALTHOUGH the "fish glue" or "enamel" process is now almost universally employed for printing the half-tone negative, there are occasions when some of the older processes are useful, and, moreover, a thorough grasp of these earlier processes is an aid to the better understanding of the "enamel" process. I therefore give the working instructions for the various well-known processes.

The Albumen Process.—Take a piece of polished zinc plate, lay it upon the polishing board, and rub it, not too harshly, in the same direction as the original polish, with the very finest pumice powder, applied with a tuft of cotton wool or piece of felt moistened with water.

Have ready an etching bath with a suitable quantity of the following solution in it:

Water	1 ounce	or	440 parts
Powdered alum	15 grains	or	15 ,,
Nitric acid	1 minim	or	1 part.

After polishing, give the plate a rinse and immerse in the above solution, rocking until an even matt surface is attained. Rinse under the tap, and remove the scum with a tuft of cotton wool.

Affix the plate to the whirler, and coat twice with the following solution, which must have been previously carefully filtered through a piece of cotton wool placed loosely in the neck of a funnel.

White of one egg, or dried albumen well beaten	10 grains	or	10 parts.
Water	1 ounce	or	440 „
Potassium bichromate ...	10 grains	or	10 „

Dissolve the bichromate in one ounce of water, and add to the egg solution, thus making up altogether about ten ounces. Add liquor ammonia drop by drop until the solution turns from a reddish colour to a bright yellow. This will keep at least a week.

The solution is poured on in a pool in the centre of the plate, and the first coating must be thrown off into the sink, as it will be too much diluted with the water on the plate. Coat again, then start the whirler, slowly at first, then quicker, for a few seconds. Detach the plate and dry carefully over the stove, allowing only a gentle heat to impinge on the plate, or the coating will be rendered insoluble. When the plate is fairly warm, blow upon it and the moisture should then be driven off.

It is quite a common practice now to whirl the plate face downwards over a stove or hot plate, and it is thought that there is not so much risk of dust falling on it. The gas fumes do not seem to affect the coating, but care must be taken not to get the plate too hot. The heating must be stopped at the point where the moisture can be driven off by breathing on the plate.

When the plate has cooled down lay it in the pressure frame upon the negative, after carefully dusting the latter with a broad camel-hair brush. It is a safe plan to warm the negative to the same degree as the zinc plate. Screw the frame up tight, and if iridescent circles appear between the negative and the front glass of the frame, it may be judged that the pressure is right.

Expose to light, putting out at the same time an actinometer. When a certain number (found by experience) is attained the zinc plate will be fully exposed. The exposure will be from three minutes in the sun to fifteen or twenty minutes in the shade. If electric light is used there is hardly need for the actinometer, as the time will be pretty constant with a given lamp. With a thirty ampere arc working at its best the exposure will be three to four minutes, the frame being placed about eighteen inches away.

When it is judged that the exposure is complete, remove to the dark room, lay the plate on the rolling-up slab, and with a composition roller ink the plate all over with a thin, even film of transfer ink, which should have been previously thinned down with rectified turpentine and evenly distributed on the ink slab. The rolling of the plate should be commenced when the roller begins to make a sucking noise on the slab. It is important that the ink be not laid on too thickly, or there will be a tendency to smudge. The ink used may be either photo-transfer or lithographic re-transfer "stone-to-stone" ink, either of which is bought ready

for use. For the dragon's blood process a stiffer form of transfer ink, and one holding more wax, is used, known as "American Etching Ink."

The turpentine must be allowed to evaporate from the ink. Then immerse the plate in a dish of clean cold water, and with a piece of cotton wool, well moistened, wipe the plate gently with a circular motion. If the negative has been of the right density, and the exposure has been right, the surplus ink will clear away readily, leaving the picture sharp, clear, and black. In case of under-exposure portions will wipe away, and with over-exposure it will be impossible to get the picture clear. If the excess of exposure is not too great, it will sometimes be found effective to add a little liquor ammonia to the washing water, or a few drops of potassium bichromate solution are often effective.

When the picture has been brought up clear on the zinc, rinse and fan the plate with a square of cardboard or other means until dry. Then dust on to the plate very finely powdered asphaltum, brushing out the surplus with a soft bristle brush. Hold the plate over the stove until the dull matt appearance of the asphaltum turns to a glossy effect. When cool the plate is ready for the etcher.

Instead of asphaltum resin may be used, but it is not such a good acid resist. A still better powder which is very largely used is dragon's blood, a red powder which is brushed on the plate until the ink is well covered, and then heated until the red image turns a deep brown. Waxed asphaltum, which is used for photo-litho, is better

than asphaltum alone, as the latter never really melts, and is apt to be granular as a covering. A mixture of resin, asphaltum, and pitch, sold under the name of Calmel's powder, is an excellent resist. Another "proprietary" article is Russell powder which seems to be a mixture of very fine blacklead and French chalk. This requires a preliminary dusting with resin, and the latter is heated until tacky, upon which the Russell powder is rubbed well in with a tuft of cotton until the image shines like a blackleaded surface. The plate is then ready for etching, and really possesses a very strong resist.

The Blue Process.—A modified albumen process has been introduced and called the "blue" process, from the fact that the image when developed is of a blue colour caused by the dye coating. The sensitive albumen solution consists of

Albumen	5 grains	or	5 parts
Ammonium bichromate ...	3 ,,	or	3 ,,
Distilled water	1 ounce	or	440 ,,
Ammonia	15 to 20 drops	or	15 to 20 ,,

The plate is coated with this solution in the usual manner, and exposed about the same time as the usual albumen bichromate print. After exposure the plate is flowed with the following solution:

Chloroform	250 minims	or	250 parts.
Benzole	50 ,,	or	50 ,,
Alcohol	20 ,,	or	20 ,,
Mastic	2 ,,	or	2 ,,
Aniline violet	2 ,,	or	2 ,,

When the solvents have fully evaporated from the

coating the plate is developed in water with a tuft of cotton. Asphaltum may be used instead of mastic.

The plates will be somewhat more difficult to develop than the inked image, but the result is worth the trouble, as the dots are very sharp and stand etching without any other preparation.

The Bitumen Process.—This is the oldest of all printing processes, but it is now practically obsolete in northern climates owing to its slowness and uncertainty. In countries where there is plenty of sunshine it is still worked with success, but I do not consider it has any advantages over a good enamel print. Bitumen is not easy to print by electric light. One advantage claimed for bitumen is that negative films (previously soaked in glycerine) may be squeegeed down on to it, and printed without a pressure frame. This, however, may be done with albumen or fish glue, by coating the plate, after sensitising, with castor oil, applied with a roller as one would apply ink. A film squeegeed down will then stick perfectly without curling up.

Ordinary commercial bitumen is unsuitable in its natural state for printing purposes. It has to be purified by washing with ether until all the least sensitive constituents are washed out. This is a tedious and expensive operation, very difficult to accomplish satisfactorily. I shall not, therefore, trouble to describe it, especially as purified bitumen can now be easily and cheaply obtained from dealers in materials for the half-tone process.

A convenient strength for the bitumen solution is

thirty grains to the ounce (30 parts in 440 parts) of solvents. The solvent usually employed is highly rectified benzole, though some workers prefer to use a mixture of benzole and chloroform. Chloroform is a most perfect solvent, but it evaporates too rapidly. The best way will be to dissolve the bitumen in two parts of chloroform, and add three parts of benzole. The benzole must be perfectly free from water; even a wet bottle will sometimes spoil it. To prevent the benzole or other solvent evaporating too rapidly and the film becoming brittle, it is usual to add a few drops of oil of lavender. Others add a very small quantity of Venice turpentine; but care must be taken to avoid an excess, or the coating will stick to the negative. The theory of adding Venice turpentine is that the purification of the bitumen takes away the sticky properties, so that the film may become pulverulent if the purification is carried too far. The Venice turpentine is accordingly put in as an inert substitute to hold the film together in development. The solution should be filtered through cotton in a closed filter.

The coating may be done with a whirler, but no time must be allowed for the plate to evaporate. The turning must be commenced without the slightest delay; also the turning must not be too quick, or a star pattern will be formed on the plate.

Another way is to select a plate larger than required, pour a good flow of bitumen along the edge nearest to you, and then quickly allow it to run to the opposite

edge by inclining it and allowing it to run off into a trough, whilst the plate is held perpendicular. Only the best part of the plate must be used with this method

It is advisable to dust the negative with powdered talc (French chalk) to prevent it sticking to the bitumen.

The colour of a suitable bitumen coating will be a rich golden hue. A very faint image is sometimes visible before development. The latter is accomplished with turpentine, which is flowed over. If the print refuses to develop it may be assisted with a piece of cotton wool gently rubbed over it. The moment all the detail is visible under the scum of turps and washed out bitumen, the plate must be placed under a strong rose tap until all the greasiness is washed away, and the image shows sharp and clean. Then the water can be blotted off and the plate set up to dry. If allowed to stand in the sun it will be strengthened. Then it is ready for the etcher.

Photo-litho Processes.—Either of the foregoing processes may be applied to lithography by applying the sensitive coating to stone, thin zinc, or aluminium as used for lithographic work. The procedure is exactly the same, except that for stone or thin plates a turntable whirler must be used, or in the case of stone no whirler at all, relying on levelling to get an even coating. A specially deep printing frame must be used, or the method of film printing used as given in our description of the bitumen process. The dusting is usually done with finely powdered resin, this being melted in

case of stone by heating the surface with a blow-lamp. After a slight etching to clean up the work the usual lithographic rolling-up follows.

Paper transfers can be prepared according to the usual photo-litho transfer process. This method has the advantage of not requiring the use of reversed negatives and heavy pressure frames, but in other respects it cannot compete with direct printing on zinc, aluminium, or stone.

Suitable transfer papers for this purpose are manufactured by Jaffé, of Vienna, whose agents in England are Messrs. Penrose & Co. The brand of paper used is known as "Eagle Brilliant." It is sensitised by immersion in the following solution :

Potassium bichromate ...	22 grains	or	22 parts.
Water	1 ounce	or	440 parts.

A sufficient amount of solution in the above proportion is made up, and liquor ammonia is added drop by drop until the solution is turned a light yellow. The temperature at which the solution is worked should be between 66° and 68° Fahr. The paper is drained and dried by squeegeeing into contact with plate glass. Printing is done in diffused light, and on removal from the frame the print is inked up with photo-transfer ink thinned down with poppy or almond oil. The surface is inked all over with a very thin coating of ink, applied with a velvet roller, the ink having been previously distributed on a slab with a composition roller. Next immerse in a dish of cold water for fifteen minutes. Lay the print then on the rolling-up board or slab and pass

the velvet roller over it again, when the ink will be picked up from the whites tolerably clean. Then go over the print with a damp sponge, wiping with a crosswise motion, until the whites are quite clear. Allow the print to dry spontaneously. Next dust over the surface with a powder composed of one part beeswax in ten parts asphaltum melted together and ground very finely. Brush off the surplus with a soft brush, and hold the print face down over a spirit lamp until the matt brown colour of the picture changes to a matt black. The print is then ready for transferring to zinc by the usual lithographic method.

The Enamel Process.—The method which is commonly known by this name has attained a remarkable popularity, and is now almost universally used throughout the world for printing half-tone negatives on to the metal. Although often called also the "fish glue process," it is not strictly correct, as the enamel or enameline process when introduced did not involve the use of fish glue, and enamel processes are still worked which have no fish glue in their formulæ.

The principle of the process is that such bodies as gum, albumen, gelatine, glue, etc., in combination with a bichromate salt, are reduced and made insoluble in water by exposure to light, and further if the metal plate bearing a film of one of these bodies is subjected to intense heat, the organic body forms an oxidation product which is insoluble in water and acids.

Gum was at first used for the process, but owing to its variable quality it requires care in selection to ensure

uniform results. The finest picked white gum arabic should only be used. Sugar in the form of sugar candy is sometimes added to make it less brittle and more adhesive to the metal.

Albumen is never used alone, but always in conjunction with the gum, glue, or gelatine. Either the fresh egg albumen or equivalent of dried albumen may be employed.

Gelatine differs so widely in quality that it is a very uncertain substance to use, and, moreover, it swells up on the plate, with also some tendency to spread. Its solution also sets when cold.

Fish glue has been found to possess the greatest advantages, and is the only substance that need be fully considered. It is always in a fluid condition, and comes on the market as a fairly uniform product, especially if the clarified kind prepared for photo-engravers' use is purchased. It has a slightly brown oil-like colour and consistency in the clarified form. The unclarified is of a whitish opalescent nature, containing a chalky sediment :

I will first give a formula for glue alone, without the addition of albumen:

Le Page's clarified glue ...	I ounce	or	440 parts
Water	I ,,	or	440 ,,
Ammonium bichromate ...	24 grains	or	24 ,,

To measure the glue, balance the mixing basin on scales and pour in the glue until the right weight is indicated. Dissolve the bichromate in the water and mix with the glue by vigorous stirring or with an egg beater. Filter

through a piece of close-textured fairly thick felt, taking care to avoid air bubbles by allowing the stalk of the funnel to touch against the side or bottom of the receiving vessel.

The mouth of the latter when not in use should be covered with a glass plate to avoid dust getting in. Dust and air bubbles are amongst the most frequent causes of trouble to the beginner.

A variation of the above formula is to add chromic acid to increase the reducing action and produce greater insolubility and adhesiveness to the metal; and also to add liquor ammonia for the purpose of neutralising the acidity, and thus making the glue keep better.

A formula with these additions which has been tried with successful results is—

Le Page's clarified glue ...	1 ounce	or	440	parts
Water	½ ,,	or	220	,,
Ammonium bichromate ...	30 grains	or	30	,,
Chromic acid	12 ,,	or	12	,,
Liquor ammonia	12 minims	or	12	,,

This will make a thin solution, but it will adhere tenaciously to the metal. The negatives must be of a perfect character to print well with this formula.

The following may be taken as a typical formula containing albumen:

Albumen, dried	15 grains	or	15	parts
Water	½ ounce	or	220	,,
Le Page's clarified fish glue...	½ ,,	or	220	,,
Ammonium bichromate ...	20 grains	or	20	,,
Chromic acid	6 ,,	or	6	,,
Liquor ammonia	3 minims	or	3	,,

The albumen must be dissolved first in the water, a portion of the water being reserved for dissolving the bichromate and chromic acid. The albumen is added to the glue, weighed as before described and well beaten. Then the bichromate solution is stirred in, and finally the liquor ammonia added. It will give the solution a slightly lighter yellow colour. The solution is filtered as already described.

It will print more slowly than the one last mentioned, and is more suitable for dry-plate negatives.

It may frequently occur that the liquid fish glue is a little thicker or thinner than usual, in which case the worker should add a little less or more than the formula, or vary the amount of water. Occasionally, too, the glue may seem more soluble than usual under development, especially in hot weather. This may be corrected by having a solution of chrome alum at hand, made up of eighty grains of chrome alum in the ounce of water (80 parts in 440) and adding a few drops to the glue solution, with careful mixing, until the glue develops properly after the regular time of exposure.

The copper or zinc plate is first freed entirely from grease by polishing it with a tuft of cotton charged with washed whiting, made into a paste with water and a few drops of ammonia. The plate is polished until dry, and when breathed upon it should show no uneven markings. Carefully dust it and clean the edges and back free from polishing powder. Affix to the whirler, and pour the solution on steadily to form a pool in the centre and spread over the plate until about one-quarter its width

and length is left uncovered all round. Whirl the plate preferably face downward over a gentle heat until dried. The whirling should not be too fast, or a thin, streaky, and spotty film will result; nor should it be too slow, or the film will be too thick, and possibly uneven in thickness. The worker will get into a uniform speed of whirling by counting the number of turns of the handle of the whirler at a determined rate. About 240 turns per minute of the plate itself is probably as near an approximation to the speed as can be given. Of course if the whirler is geared the handle goes more slowly in proportion to the gearing.

When the whirling is finished, if it has been done over a stove, the film should be quite dry up to the edges, and of a transparent yellow colour, with glazed surface. Any dust spots or air bubbles will be easily visible.

The plate and negative should be brought to an equal degree of heat and dryness, and placed in contact with each other in the printing frame, which is then screwed up with the usual pressure.

The exposure will be, as a rule, about twice as long as for an albumen print, and will register six tints on the Penrose actinometer.

On removal from the frame, the plate is placed in a dish of water to soak for a few seconds, then a solution of methyl violet aniline dye is poured on. The proportion is not important, as the object is only to stain the film, nor need violet dye be necessarily used. Any dye will do, but choice should be given to those which

show up well on the metal plate, as the intention in using the dye is to enable the development of the image to be watched. Add one ounce of dye to twenty ounces of water (22 parts in 440) and dilute if necessary. The solution should be filtered if it has a curdled appearance or is full of undissolved particles.

After about a minute's immersion in the dye, the plate is put into a dish and water allowed to run over it in a gentle stream until the bare metal is visible between the dots. Some experience is necessary to determine when the development is complete, as a slight transparent film of glue is sometimes left if care is not taken to wash out thoroughly. A final rinse with warm water is effective for removing this last trace of glue. The plate is next drained and placed in a bath of methylated spirit, which absorbs the water and dries the image. The dye will probably have dissolved out by this time, but having served its purpose it is now unimportant.

The next stage is the "burning-in." The plate is held in pincers over a gas stove with the flame in contact with the back of the plate and moved to and fro, so that the heat may not act too long in one place. The first effect will be that any traces of the dye will disappear, then the image will turn yellow and gradually deepen to brown and finally almost to a black. At the deep chocolate brown stage the heating is stopped and the plate laid on a piece of asbestos to cool. It will be hot enough to burn wood, and if placed on iron or stone the sudden cooling may cause the film to crack.

Copper will stand almost unlimited heating, and the "burning-in" is usually carried to the stage where the bare copper assumes a silvery appearance. Zinc must be heated more carefully and stopped at an earlier stage. Over-heating will speedily show on zinc by the metal assuming a crystallised appearance, the surface being covered with minute cracks. The metal will be very brittle when cool, and will snap with very slight bending. If the heating in the case of copper or zinc is carried to the black stage, the film will be burnt and will not stand the etching.

Causes of failure will be unsuitable negatives, over or under exposure, insufficient development, too much or too little heating.

Unsuitable negatives will be such as have the dots insufficiently joined up in the high lights and give a cross-line appearance, dots being joined up on the metal; or, on the other hand, negatives which are too much joined up, and which print the dots too small on the metal so that they wash away. Again, there are negatives with too large dots in the shadows, thus yielding greyness in the shadows printed on the metal; the opposite effect will be quite transparent shadows on the negative with no dots at all, or only very weak ones. In this case the film seems to have a tendency to lift and wash off.

A "Cold" Enamel Process.—A good deal has been heard of late concerning a mysterious "cold" enamel process, by which it is implied that the enamel requires no heating. The process seems to vary with each

vendor of the "secret," so that it is impossible to say which is the veritable "cold" enamel. One puts forth the "blue" process already described as entitled to be called by this name, but this may be put out of court, as the majority of the "cold" enamels have a glue basis. Either fish glue or Cologne glue is bichromatised and printed in the usual way, but it is only moderately heated. The etching is then done in a bath which does not readily attack the film. This portion of the process we will deal with in the chapter on etching.

The following formula for the printing solution is as good as any: One hundred parts of Cologne glue are soaked in six hundred parts of water for twelve hours and then melted on a water bath. To this are added three parts of dry albumen, dissolved in a little water. The mixture is heated up to 212° Fahr. for fifteen minutes. It should then be filtered and allowed to cool. Sixty parts of this solution should be mixed with 3·5 parts of dried albumen, previously dissolved in thirty parts of water, and then mixed with thirty parts of a ten per cent. solution of ammonium bichromate. The solution should be again filtered. This solution will keep in a cool dark room three or four days. The plate should be warmed before coating. The printing will take from forty-five to sixty seconds in the sun, and five to eight minutes in the shade. Development is done with pure water exactly as for the fish glue process, and as a variation on the dye stuff Victoria green may be used. If it washes out in development immerse again

in the dye after development, and then allow the plate to dry. The plate is then heated to the stage at which the dye disappears and the film becomes yellowish. When cool the plate is ready for its special etching process.

The "Dry" Enamel Process.—There is one other process which must be mentioned, which goes by the above name, and is also heavily charged with "secrets," so that one does not quite know which is the orthodox formula. All the "dry" methods are, however, alike in one respect, viz., that the sensitive film is made of a hygroscopic nature, and is dusted with a powder after exposure. The powder adheres to the film in the unexposed parts, showing the print brown on a white background. With a tuft of cotton carefully handled the powder will develop dark parts and give the operator a wide range to bring effect into the picture at this stage. By breathing, for instance, on a dark spot and applying the powder carefully, details can be brought out which no other method will do.

A formula for the sensitive solution is as follows: The whites of three eggs are beaten with four ounces of water, to which are added half an ounce of ammonium bichromate and one and a quarter ounces of white rock sugar candy, ground up and dissolved in six ounces of water. In a separate graduate are dissolved eighty grains of chromic acid, to which are added fifty drops of liquor ammonia mixed with the former solution. The ammonia must be added gradually or the albumen will be coagulated. Some operators use dextrine in place of rock candy.

After careful filtering, the plates are coated in the usual way on a whirler. Care must be taken to have the negative and plate quite warm, as the coating absorbs moisture from the atmosphere very readily, and the plate and negative may accordingly stick. A good preventive of this is to flow the negative with paraffin oil, and to drain and blot off thoroughly; a coating of indiarubber solution is also effective. The exposure is two to five minutes by electric light.

The exposed plate is now laid down to cool and absorb moisture in the unexposed parts. A large basin of water or a large wet sponge standing in the room will promote this action. The powder consists of either stannate of soda, anhydrous carbonate of soda, calcined and powdered washing soda, or calcined carbonate of magnesia. The latter is the most reliable, and is not so harmful as the others if it gets up the nostrils or in the throat. The substance is finely powdered in a mortar and sifted with a fine sieve. This powder is mopped over the print with a tuft of cotton and will attach itself to the unexposed parts of the picture. With a soft powdering brush such as that shown in fig. 75 the surplus powder is brushed off. The method of aiding development by breathing on the plate must be done carefully or the plate may be easily spoilt. When development is completed the plate is burned-in to a dark brown colour, and then put into a saturated solution of potassium bichromate, in which it should remain some minutes or until the coating in the unexposed parts comes off or loosens. From this

solution put it in a ten per cent. bath of hydrochloric or sulphuric acid, and with a tuft of cotton the plate may be cleaned perfectly. It is then ready for the usual etching process.

CHAPTER XIII.

ETCHING THE PLATE.

IN all the methods of printing described in the last chapter we have left the plate at the stage where the etching begins. The procedure from this point will depend on the process by which the print was prepared.

Albumen Print on Zinc, rolled up with Transfer Ink and dusted with Asphaltum.—A very weak acid bath is prepared. A practical etcher would call it vinegar strength, and would judge it by tasting, but it may be taken as of about one ounce of nitric acid in one hundred ounces of water. It is called a "passing" bath, and the plate is given two or three rocks in it, just sufficient to dull the surface. The slight scum formed by the etching is quickly wiped off under the tap by means of a brush or tuft of cotton wool and the plate rinsed free from acid; then dried by slight heat and by fanning or blowing upon it. The object of this "pass" through the acid is to clean the surface. In this condition it will take any retouching better. If the ruled border line was not cut on the negative it should be ruled on the plate now with a mathematical ruling pen charged with either Lemercier's lithographic writing ink or with a solution of asphaltum in turpentine, and a little oil of lavender added to prevent it drying too quickly. Some workers also add a

little white wax. All the spotting, ruling, and other retouching is done with either of these inks, and the name of the engraver put in if a business block. Circular or elliptical border lines are also put in at this stage. Any portions of the work required to be quite white are scraped away, or any parts wanted in solid black are painted over.

The next step is to varnish the back of the plate with an acid resisting varnish, which is usually made up by dissolving shellac in spirit. Such a varnish may be bought ready for use, under the name of "Acid Resist" varnish. The margins of the plate within about half an inch of the border lines are also painted with this varnish. As it runs rather freely, care should be taken that it does not run into the work. It is a good plan to stand the plate up face to the wall when varnishing.

On the margin of the plate scrape away a broad line about half an inch in length. This exposes the zinc to the acid, which etches away a place where the depth of the etching may be tested by feeling with the thumb nail. This is called the "guide mark."

The plate is warmed and a little asphalt powder is brushed over the retouched parts. The surplus is brushed away carefully, and the plate again warmed to fix the powder.

Add one or two per cent. more acid to the bath used for "passing"—the strength being determined by the fineness of the work and the resistance of the film. The plate may now be put in the acid and etched until a perceptible depth can be felt in the guide mark. It is

impossible to give a certain time for etching, owing to differences caused by temperature, the quality of the zinc, the purity of the acid, and the strength of the resist on the plate. It is not likely to be more than fifteen minutes. The work must be carefully watched, and if any tendency to over-etching is apparent, the plate must be quickly taken out and rinsed. It should be examined with a powerful magnifying glass to see if the dots are intact, and whether it has received sufficient depth. A proof taken at this stage will show whether a printable depth has been reached. In taking this proof it is a good plan to ink the plate with a rather soft composition roller, and somewhat thin ink, also laying a piece of printer's blanket over the two or three sheets of paper which form the press backing. If the plate will stand this "soft" impression it may be certain it will suit the average style of printing in the hands of the customer. The plate may then be regarded as finished, unless it is thought that "fine" etching is needful. This will be dealt with later on. If the plate is shallow further depth can be attained in the process of "fine" etching.

The nearest standard for the depth is to endeavour to make the latter equal to the width between the dots. In the case of coarse screens this would probably not be attained in one etching without danger of undercutting. The method of re-etching will be presently described.

The bath must be rocked all the time during the etching—a gentle rocking so as to move the acid

solution to and fro over the plate. An etching brush must be used to clear off the scum as it accumulates, but must not be too freely applied or the dots will probably be reduced.

If dragon's blood, resin, or other powders are used instead of asphaltum, the procedure in etching will be the same, except that some may stand more etching than others.

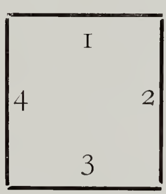
Plates produced by the "Blue" Process.—The passing, retouching, etc., will be the same as in the foregoing, and the prints will stand an acid bath of from two to five per cent. in the first etching. Extra depth should be obtained by re-etching. "Blue" prints are generally on zinc, so that it is unnecessary to refer to copper etching.

Bitumen Print on Zinc.—The plate will stand the "passing" bath the same as for albumen prints, but somewhat more care must be taken not to overdo this first "bite," or the bitumen will be robbed of its "grease" and will not roll up. Retouching and other preparations are done as before. The plate is warmed up to 120° or 160° Fahr., and when cool etched in a two per cent. bath for one minute. Then it is rinsed, dried, and gummed, as for the rolling-up method. When the gum is dry, the plate is wiped with a sponge and damp rag, and rolled up with the best black chalk litho ink, applied as stiff as possible with a good nap roller. The etching is then continued as far as it is possible to go, with the acid increased to three per cent.

Photo-lithographic Print transferred to Zinc.—The preliminary operations are the same as for albumen prints.

For the first etching warm the plate slightly to fix the image; etch in a two per cent. bath for one minute. Dry the plate. Gum, and roll up with good lithographic ink, "starting" ink—stiffer than for line work—or with chalk litho ink, and then etch to the right depth. Dusting is done with resin to increase the "resist."

Dragon's Blood Process.—For deep etching of very coarse half-tone work, as for posters, and for etching line borders or half-tones, this process is an expeditious one, and saves the use of rollers. The image is printed by the albumen process, but it should be inked with a very stiff etching ink known as the American Etching Transfer Ink. It is given a surface dusting with dragon's blood, then put through the "passing" bath, retouched, and otherwise prepared, and etched for three to five minutes in a five per cent. bath. The plate is then rinsed and dried, heated strongly, and brushed with the dragon's blood powder in one direction only. Suppose the sides of the plate are marked thus:



The first brushing should be from 1 to 3. The powder is thickly applied with a tuft of cotton wool, and then the surplus dusted off by stroking the brush (fig. 75) in the direction indicated. By this means the powder is left lying against the side of the lines or

dots, like drifted snow. The plate is heated to fix this powder, and when it has cooled down enough to avoid the powder sticking to the bare metal, another brushing is given in the direction 2 to 4. These operations are repeated for the remaining two ways. The plate will then stand very strong etching with ten per cent. or more acid, and if sufficient depth is not then attained a further powdering four ways can be given and another etching.

Rolling-up Process.—This also is only used for very coarse half-tone or line work. The print is made as usual by the albumen process, and the inky image is dusted with very finely powdered resin, applied with brushes similar to those in the dragon's blood process. The plate is slightly warmed, only just sufficient to fix the resin; then the plate is given a "pass" through a weak acid bath. It is then rinsed and the scum wiped off. The water is blotted off and the plate fanned dry. Thick gum is smeared over the surface of the plate and allowed to dry. A good nap roller is charged with the soft etching ink, known as "starting" ink, used as stiff as possible. If too stiff when purchased it is thinned down with middle varnish, but great care must be taken not to make the ink too thin. Also there must not be too much on the roller. The gum is sponged off, and the plate wiped with a clean soft linen rag, damped but well wrung out. There must always be a thin smearing of damp gum on the plate during the inking. If one ounce of gallic acid is dissolved in a pint of water, and an ounce or two of

this solution added to the gum, it will help to keep the ink from smearing the plate or filling up the work. When the picture is rolled up to good strength the plate is rinsed and sponged free from gum, and fanned dry. It is then dusted again carefully with the fine resin, but not warmed this time. The back and margins are painted with acid resist varnish, and it is ready for the first etching.

The Finishing Etch.—In the foregoing processes it is generally desirable to give a "finishing etch," as it is termed, or re-etching. The resist is cleaned off with turps or paraffin in the case of ink, resinous or bituminous images, or with methylated spirit in case of the "blue" and "dragon's blood" processes. The plate is afterwards scrubbed clean and bright with caustic potash solution. A little whiting sprinkled on will give increased brightness to the plate. All dust or grit must be brushed out of it before the roller is applied. The glazed roller is charged with a thin even coating of "finishing" ink, and the plate rolled whilst it is as hot as the hand can easily bear. The effect of this rolling is to deposit ink only on the surface, without any tendency to cover the sides of the dots. When the image is nicely black the plate is warmed until the dull ink shines. On cooling the etching can be renewed with a two per cent. bath for perhaps one or two minutes. This results in the dots being sharpened up, and any roughness in the depth of the plate smoothed down.

The Enamel Process on Zinc.—The plate after being burnt in and cooled is retouched and varnished in the

usual way. The etching is preferably done with a one per cent. bath. Although this may prolong the etching to about forty minutes in the case of a plate of average depth, there is no risk of the film lifting or the edges of the dots etching ragged. Some etchers prefer to give a short " bite " with strong acid, say five per cent., believing that the etching can thus be completed before the film has time to soften. Whether the strength of the acid can be increased and the time of etching shortened will depend entirely on the printer; the etcher has little or no control. If the film blisters and leaves the plate the acid is too strong or the exposure of the print too short, or the burning-in not sufficient. If the film crumbles away in powder it has been over-burnt. The tendency of the film to be attacked may be prevented to some extent by adding to the etching bath one ounce of chrome alum for one hundred ounces of bath solution. It is not desirable to give a finishing bath in the case of enamel plates, as the delicate sharpness of the dots is impaired, and the plate assumes quite a different appearance, wanting in the cleanliness which distinguishes the original image. "Fine etching," however, may be done as subsequently described.

Where the burning-in has been overdone on zinc the etching will immediately show the crystalline structure into which the zinc has been broken up. There is, indeed, always a granularity in zinc etchings which have been prepared by the enamel process, owing to the heating of the plates in burning-in.

[illegible] TONE
[illegible] FINE
[illegible] PLATE
[illegible] SCREEN

BLOCK MADE BY
BRITISH PHOTO
ENGRAVING CO.,
COVENTRY.

THE SAME, WITH
150 LINE SCREEN

THE SAME, WITH
175 LINE SCREEN

It has been stated that this granular appearance may be avoided by first immersing in a weak solution of chromic acid. If now the plate is put in the ordinary nitric acid bath the etching is very rapid. When the yellowish brown precipitate is wiped away the etched ground is seen to be quite smooth.

Another way which it is said will secure clean etching is to add "slimy" substances such as gum, fish glue, dextrine, etc., to the nitric acid etching bath. The effect is to retard the irregular action of the acid. If this mixture is used after the chromic acid bath mentioned above the effect will be to make the etching smooth and regular in the hollows.

Sulphate of iron has also been suggested as a mordant for etching zinc, used in a strong solution, but its action is slow.

Another etching solution for zinc which has a mild and a regular action is the following: Nitric acid, 130 parts; water, 100 parts; sal ammoniac, 20 parts; pyroligneous acid (wood vinegar), 20 parts. The constituents of this bath should stand two or three weeks after mixing.

Etching Plates prepared by the "Cold" Enamel Process.—There are several methods. One consists of adding formalin to the nitric acid bath, or immersing the plate previously in formalin. Another is based on making up a solution of iron perchloride in which the free acid is "killed" by the addition of hydrated iron oxide—prepared by adding liquor ammonia to a solution of iron perchloride. The hydrate is thus

precipitated, and may be filtered out and washed free from ammonia, which may be ascertained by testing the droppings from the filter with red litmus paper. The hydrate is then added to the iron perchloride solution until it will dissolve no more, thus indicating when it is neutral. In this condition iron perchloride will etch zinc fairly well, and the iron solution will not attack the film.

Another method is to take six ounces of dry crystals of iron chloride and one ounce of dry zinc chloride, and rub the same down in a mortar with ten ounces of alcohol, sp. gr. ·810. When dissolved 160 minims of nitric acid is added gradually. It will be seen that the solution is an alcoholic one, and that in itself will prevent the film being attacked, whilst the other substances are etching the zinc.

It is not necessary to complicate the formula however, as alcohol and nitric acid form as good a mordant as any for etching "cold" enamel. The etching fluid suitable for the Cologne glue formula described in the last chapter consists of four hundred parts of forty per cent. alcohol and five parts pure nitric acid. For strongly printed plates this may be increased to six or seven per cent. If the shadow details do not come up the plate may be laid for one to two minutes in a one to one and a half per cent. bath of water and nitric acid.

Etching Enamel Plates of Copper or Brass.—The etching solution for both these metals is one of iron perchloride. This is made by taking the solid

perchloride,* which is in hard, yellow lumps, and dissolving it in hot water. About $1\frac{1}{2}$ lbs. of iron perchloride to one pint of water will bring the solution to the required strength; but it is necessary that the solution should be tested with a Beaumé hydrometer, already illustrated and described (fig. 72), and should register somewhat over 40°. The solution can also be bought ready made at a strength of 40° Beaumé. In practice it is found that 35° is an average strength suitable for etching, and the stock solution is diluted down to this. A solution at 30° or even 25° will etch the plate, but it is to be noted that the thinner the solution the stronger is its action on the film. With a good quality of copper and a perfectly developed print the etching is a really simple operation, the plate having merely to be placed in the solution for a sufficient time. The trough need not be rocked, though some do so. If the etching is slow and there seems to be a deposit in the hollows to be etched, a gentle brushing may be done with an "atzpinsel" or other very soft brush. American copper etches clean, the copper being laid bare and having a pink colour, but some other kinds of copper have a heavy green deposit in etched parts. This result, however, is sometimes due to the etching solution being too old. When the plate is taken out for examination it should be well rinsed and brushed with a soft brush. Any mottled appearance which results may be disregarded.

* "Persal" is a double recrystallised and purer form of perchloride recently introduced, and is well spoken of.

Some etchers have great faith in etching the plate face down, holding it in wooden clams, so that it is within about half an inch of the bottom of the dish. The plate should be moved to and fro, to make sure that there are no air bubbles under it, and then left for five or ten minutes to itself.

The time of etching will vary from five to fifteen minutes, according to the fineness of the work, the extent to which the plate has to be fine etched, and the state of the solution.

Brass is sometimes used in place of copper, and is also etched in iron perchloride solution of the same strength as for copper. Some kinds of brass containing a larger percentage of zinc may require a more dilute solution.

If a green scum is left on the copper after etching it may be removed by immersing the plate in the following bath :

Water	20 ounces.
Chromic acid	I dram.
Sulphuric acid	I dram.

This is also sometimes used at the commencement of etching for cleaning up the plate.

Occasionally trouble will arise through a scum of glue covering what should be bare metal between the dots, and this will retard the etching for some time. The application of a potassium cyanide solution, about one ounce in twenty ounces of water, will soften this scum and permit it to be washed away.

Continual brushing of the plate during the etching is not to be recommended, as it tends to rub away the

fringe of the dots, and gradually reduces them until they are etched away. Instead of brushing the plate before examination of the dots with a magnifier the solution can be drained off and the plate blown upon until the etching solution is forced aside and the copper may be plainly seen.

Wiping of the plate with a cloth is equally destructive to the enamel on the dots. The best way to dry the plate is to dab it with a chamois leather made into a pad.

"*Fine*" *Etching*.—This is also called re-etching, re-biting, and "staging" (American term). Its object is to force contrast. Some subjects require no "fine" etching if the previous operations are correctly carried out, yet there are practical workers who believe that every half-tone plate can be improved by this process. The effect of photographing the original through the screen certainly alters the scale of gradation of the tones and makes it somewhat flat. In a bad original this effect will be exaggerated.

Probably in a landscape the sky may be dull, or in a portrait the background may be so heavy in colour that it "kills" the portrait. In all cases the object of "fine" etching is to lighten; it is impossible to darken, except by burnishing, which will be described subsequently. But it is obvious that by increasing the brilliancy of the high lights we apparently increase the strength of the shadows by the force of contrast. "Fine" etching must be done by a man with some amount of artistic perception. The first step is to get a good proof, and compare this with the original.

Some whiting or magnesia is rubbed into the plate with the ball of the finger and wiped off with the palm of the hand. If the print is in good dark brown enamel the effect can easily be judged. If the plate has been prepared by any other process it should be inked with stiff and very black ink before the white is rubbed in.

The plate should be carefully compared with the copy. If it looks very dull it may be necessary to give it a light etching all over, as the "deep" etch has evidently not been carried far enough. Enamel prints should stand this re-etching without further preparation; but plates from which the resist has been removed require to be inked with the glazed roller and "finishing" ink as already described to give them a "top." It may be advisable for this general etching to stop out one or two small parts, such as a high light which has already been etched as far as it will go, or a deep shadow which would become grey by further etching, owing to the tiny white points in the shadow being enlarged.

After this preliminary stage the shadows and most of the middle tones should be about right, and may be "stopped out," leaving the lighter half-tones, graduating to the high lights, to be dealt with. The plate is again filled in with whiting, and its effect studied. It will probably be found that a nearly white object against a light background hardly possesses sufficient contrast, so that it is almost impossible to tell where the white object ends and the background begins. If the original shows that the background is

intended to be the darkest, that must be "stopped out" with varnish so that it cannot be any further etched. More or less fine sable brushes are used for the stopping-out, and one must not attempt to be too detailed in the painting. We must adopt a style which painters would call "washy." There must be no clean, straight edges to the stopping. One must try to finish up near the boundaries of the shadows.

It is impossible to give any reliable rule as to the strength of bath and duration of etching. In using nitric acid the bath must not be more than about two per cent. For copper etching the usual perchloride bath may be used, and the action of the etching determined by time. The period during which the plate is in the bath will be very short, as one, one and a half, two, two and a half, three, three and a half, or four minutes. The beginner will soon find that a half minute makes a great difference to the result.

Further "stopping-out" and etching can be resorted to *ad libitum* according to the fancy of the etcher, but excessive "fine" etching is to be avoided, as it may absolutely spoil the delicacy of the tones obtained photographically, and moreover make the block difficult to print.

Vignetting.—This is an extension of the principle of "fine" etching, and is a most difficult operation to perform successfully. The subject must in the first place be suitable for vignetting, and the operator should have made a negative in which the white margin surrounding the vignette is well closed up so as to

print fine dots on the metal. By the use of Holt's vignetter this effect may be secured during the negative making, even in the case of subjects which are somewhat dark at the margins. The printer must endeavour to make prints in which the dots will be fine yet strong. The deep etcher can do a good deal towards softening off the plate towards the edges by manipulation of the etching brush. By working it round and round the plate the etching is allowed to go on more quickly in these portions owing to the oxide being removed. Care must be taken not to leave the dots too small and rotten so that the fine etcher cannot deal with them.

The first step to be taken by the fine etcher when he gets a plate to be vignetted is to rub it in with white and mark out the extreme boundary of the vignette with a steel point. The margin outside this is stopped out with varnish.

Starting from the centre the picture is entirely stopped out, to the point where the picture begins to vanish into the vignetted edge. This will probably be about three-quarters of an inch from the scratched outline in case of a cabinet portrait. Care must be taken not to leave a hard edge to the stopping-out varnish, and to avoid this a hog-hair brush as used by painters should be employed. The flat shape is best, and two or three sizes should be at hand. Taking up a brushful of varnish it should be well worked on the blank edge of the plate until tacky, without any tendency to flow. Then, hold-

HALF-TONE MADE IN THE ORDINARY WAY.

HALF-TONE MADE WITH HOLT'S VIGNETTER.

ing the brush vertical, use it as a dabber on the edge of the stopped-out centre of the picture, using less and less pressure as it approaches the boundary at which the etching is to stop. When the varnish is dry a one minute etching is given. The plate is then dabbed dry with the chamois leather pad, and the stopping-out extended about a quarter of an inch with the hog-hair brush, with perhaps a little touch of the ordinary stopping-out brush to make a solid joining up. Another one minute bath is given; and again the stopping-out is advanced a quarter of an inch, and a further etching given. The part nearest the scratched outline will accordingly have received the deepest etching, and will print the lightest.

The whole of the varnish is cleaned off, the plate filled with white, and the "fine" etcher proceeds with his usual course of "fine" etching to improve the tones. He at the same time should lead them into the vignetting he has already done, so as to avoid a kind of high-water mark all round the picture which is often seen in badly finished vignettes.

"Cut Out" or "Deep Etched" Half-tones.—In this case backgrounds and high lights are cut away, as well as vignetting and fine etching done to heighten contrast. This cutting out is best done before the fine etching and vignetting begins. A good deal of it may be stopped-out on the negative, and other portions scraped away before the first rough etching of the plate. The "fine" etcher has then only to work down to the cut out portions, softening his edges.

A general hint applying to all cases of re-etching is that plates which have been inked and are greasy and dirty should be first thoroughly cleaned by brushing with a mixture of equal parts of alcohol and acetic acid; or sometimes acetic acid and common salt is used. This treatment is in case of copper only. Zinc can be cleaned with caustic potash and whiting, whilst the plate is hot.

CHAPTER XIV.

FINISHING, MOUNTING, AND PROVING.

WHEN the plate leaves the hands of the etcher and fine etcher there may be some work to be done on it by the engraver, who, if skilful in metal engraving, can greatly enhance the result.

The simplest case will be that of taking out spots between the dots. This is generally done with a thin graver known as a "knife edge graver."

To fill up a white spot or repair a scratch is not so easy, but it can be done by forcing up the metal round it by means of a sharp pointed punch inserted between the dots, or punching the plate from the back, after marking the position of the faulty place by callipers on the back. The raised metal is then levelled down by scraping and burnishing.

The engraver often cuts a white line inside the black outline made on the plate before etching. He also rules or trims up and white lines any circles, ovals, or other borders.

His duty is also to cut the imprint, though this has been superseded to a great extent by impressing it with a sharp punch. It is sometimes advisable even in this case to trim and sharpen it up with the graver.

In the case of vignetted and cut out work which has to be cut out on the routing machine, the engraver

usually goes round the part to be routed with a "scorper" (a round backed graver) forming a channel for the router to work up to.

The edges of vignettes are often made to print lighter by entering the white lines between the rows of dots with a "tint" graver, and thus reducing the dots. Sometimes alternate rows of dots are removed, and in the case of very fine screen work, as 175 lines to the inch, white lines may be cut with the "tint" graver at an angle of 45° to the lines of the screen, the spacing being made coarse, say ninety to a hundred lines to the inch. It is a mistake to try to imitate the ruling of the screen when cutting white lines. Blocks from artists' wash drawings are very often elaborately worked over with the graver, until the result resembles a wood engraving.

"Cut out" catalogue illustrations can often be greatly improved by putting in high lights with the graver, and trimming up with the scorper any rough edges left by the fine etcher.

"Many liner" gravers are very useful for softening edges. These are gravers making a number of lines at one cut. They are to be had in a great many degrees of fineness, and with a varying number of lines on them.

In the case of views, machinery subjects, etc., the sky in the former case, or the background in the latter, may be stopped-out before any etching is done, so that when the proof is taken the parts print black. The plate can then be handed to the engraver, and the usual

engraving effects put in. A plate may also be stopped-out in parts before etching, and afterwards these parts laid bare, whilst the etched parts are stopped-out, the plate being put into a dusting box such as is used for the photogravure process, and a grain deposited. The plate is then again etched. In the same way tints from stippled or ruled plates or shading mediums can be transferred. Or by some careful system of registration different parts of a plate could be printed with negatives having a grain of different degrees of coarseness or pattern, the plate being resensitised each time.

Besides engraving a great deal may be done by means of the burnisher and roulette. These tools have already been described.

To use the burnisher it is rubbed on a piece of hard yellow soap, then held near the point between the thumb and first finger, the handle being under the hand, not as in holding a pen. The flat part of the blade is then rubbed on the part to be burnished until the same is bright, using a sufficient pressure, but not so much as to make hollows in the copper. This kind of burnishing is done with a blunt ended tool and covers fairly large spaces which it is desired to darken, or it follows any repair work where the surface has been injured. Finer pointed burnishers are to be had in great variety, and are held like a pencil or crayon, being used for working up fine detail. In all cases it is to be remembered that rubbing down high light dots darkens them, whilst rubbing down shadows closes up the white dots, and thus makes the shadows print

blacker. Any part of the metal which has become roughened or corroded will print solid if burnished. The enamel must be removed before burnishing.

Rouletting is the exact opposite of burnishing. Its effect is that of lightening any dark parts. For instance, the shadows of the draping of a dress may be too dark and harsh. Then by applying the roulette the dark part is stippled with white dots. It requires considerable practice to acquire the knack of applying a roulette which is flat, so that it makes all the dots the same depth and size; also to avoid slipping and scratching the plate. The roulette should be chosen something like the same grade as the screen. Single row or spur roulettes may be used against a straight edge for making dotted lines. There are also broad roulettes cut with lines instead of dots, and these may be run round the edges of vignettes. Roulettes are held the same way as burnishers, already described, or sometimes with the handle of the roulette between the first and second fingers.

It is generally desirable lightly to burnish over any work that has been rouletted or engraved in order to remove any burr thrown up.

The plate is always filled with white before any tool work is done on it, and further white is rubbed in as the cutting proceeds so as to get an idea of the effect. Any delicate touches of the graver should be done under a magnifying glass of about two inches focus, and the effect further examined with a higher power.

The bevelling or routing is the next stage. We have

already described the bevel plane, and also the bevelling machine and router.

If the plate is a straight-sided one with rules, there is nothing to be done but to bevel up to the rule. With the shoot plane the chief thing to attend to is the sharpness of the cutter, especially the angle which makes the double cut to form the bevel and its shoulder. One should not attempt to cut too much at once or the forward end of the cut will be too deep, and the cut may be wavy. It is very probable that in trying to trim up to the rule in this case the latter will be cut away unevenly. The cutter should be set so that the full length of the cut may be taken at one thrust of the plane. Zinc is easy to cut, but copper will require more exertion for the same depth. The tool should be slightly more acute than for zinc. A little paraffin assists cutting in case of zinc, and oil or soapy water for copper.

With the bevelling machine the only care needed is to keep the cutters sharp, and ground at the right angle. A gauge can be obtained to show this. The same cutters do for either zinc or copper. The use of the lining beveller can be best explained alongside the machine by the maker's representative. The cutters must be kept exceptionally keen edged to do neat work and one must learn first of all the direction of the various screw adjustments, getting them all into line with their micrometer scales at zero; then it is quite easy to work forward and back again. The greatest skill is required in stopping the cutter at the corners of

the rules. Some workers will not attempt going very close, preferring to finish the corner with a graver. The work can be better seen if the plate is filled in with white. It is necessary to have an incandescent electric lamp close to the work, and a piece of mirror is also an aid in seeing the progress of a cut, the reflection being viewed instead of the original plate.

The routing machine is very simple to work, but its success depends entirely on knowing how to sharpen the cutters. They only need to be sharpened on the end facet. The sides must not be touched. Different cutters are used for zinc and copper; for the latter metal they are fluted. The cutter should be brought gradually down to the plate, or will be snapped off if forced to make its full depth of cut at first contact. The cut is usually made about half-way through the metal. For trimming round a vignette or "cut-out" the plate is tacked on a piece of mounting wood and the cut taken right through. The cutter should always be moved to the right and forward towards the operator; if pushed in the opposite direction it will not cut so well. Small size cutters should be used for working in narrow spaces and following intricate lines. If the cutter throws up a burr one of two things is evident—either the cutter is not properly sharpened, or the machine is not running at its right speed. It needs very careful and regular oiling with a thin oil, and the belts must be kept in good tension.

In the case of all machine cutters it is best that they come into contact with the grindstone as seldom as

possible. Only in case a point is broken off should they be applied to it. A good oilstone should be sufficient to keep them in order for a long time. If very blunt or rounded a quicker cutting may be obtained by rubbing them on to a piece of zinc or copper covered with emery powder and oil. It is a good plan to keep a new cutter always at hand for comparison.

After the bevelling and routing, the final proof is generally taken, the plate being laid on the iron type high block on the press. In this way a solid and perfectly true backing is assured, and if thought desirable the waste margin outside the bevel or routed edge may be left on to act as a bearer to keep the pressure from being too heavy at the edge. This is especially useful in the case of vignetted or "cut out" work. A further advantage of proving before the plate is put on the wood mount is that the latter can then be sent out to the customer quite neat and clean, instead of being stained with ink and turpentine, as it probably would be if the proof were taken with it attached to the plate.

The plate must first be well brushed out with turpentine and dabbed clean and dry with a fluffless rag. The back should also be wiped and care taken that there is no grit underneath when placed on the press.

The ink should be as stiff as it can be worked and well distributed with a hard and slightly tacky composition roller. A good black with a slight trace of blue in it is the best for yielding a good commercial proof. It must be applied to the ordinary block with frequent rolling in every direction until the shadows look solid.

The paper should be of the coated and calendered kind, with an almost equally good surface on both sides, and at least 60 lbs. weight per ream in royal size (25in. x 20in.) There will always be one side of the paper slightly better than the other, the worst showing the wire markings. The paper should be laid out or thrown over lines to absorb a little moisture from the atmosphere, making it take the ink better, and giving it more flexibility, which ensures freedom from slurring. About three sheets of stout smooth paper should be laid on top of the proof sheet, and the whole backed with a sheet of glazed pressboard or smooth cardboard. Some provers use a piece of printers' blanket and others thick indiarubber sheeting. If the impression is not even and strong the ink will be left on the plate in mottled patches, and the proof will be grey and patchy. It is good to let the pressure "dwell" on the plate for a few seconds to give the ink time to absorb into the paper.

A plate having very heavy shadows and great contrast sometimes needs underlaying. This is done by cutting out corresponding parts from a proof and attaching them to the back of the plate in the proper position. In some cases two or three thicknesses may be required, in which case each layer should be made a little smaller and the edge scraped down so as to taper off, or the underlay may cause a kink in the plate which it will be difficult to straighten out again.

The tapered underlay is especially necessary in proving vignettes, which must be built up so that the

surface is slightly convex, with the highest point corresponding to the darkest part of the picture. It is also necessary to supplement the effect with a convex overlay similarly built up of layers tapered off at the edges. This overlay is mounted on a stiff sheet of paper or cardboard the same size as the proof paper, and some means adopted for registering it in position in relation to the plate, which must be laid to marks on the bed plate, and if the press has a tympan the overlay should be pasted on it. Otherwise a makeshift will be to paste strips of cardboard with drawing pins stuck through heads downwards on the bed plate alongside the etched plate to act as registering points. A still easier way of registering often used in proving three-colour work is to have two long sewing needles stuck in short lengths of cane, and to have two small holes in the margin of the plate to be proved. A proof taken on the overlay sheet will show the position of these holes, and the needles can be stuck through at these points. The overlay sheet and proof sheet together can be lifted by means of the needles and placed in position by inserting the points of the needles in the holes in the plate. Not only vignette overlays but the usual make-ready overlays may be applied by this means.

Some firms adopt the plan of sending the overlay with the block, so that the printer may have no further trouble in preparing it.

Various methods of preparing overlays for half-tone blocks have been suggested and some have been

patented, but it cannot be said that any have come into popular use. Husnik's gelatine relief overlay was perhaps the earliest. It was made by coating stout paper with gelatine, sensitising with bichromate, and printing it under the negative from which the block was made, or under a plain negative without dots. On soaking and washing this gelatine sheet, the lighter, least exposed portions were washed away, leaving the shadows and half-tones in more or less relief. When dry this formed a perfectly graduated flexible overlay.

A recent modification of Husnik's overlay proposes that the gelatine relief be used to make a mould in plaster of Paris, and from this latter a guttapercha cast is taken and used as the overlay. To avoid having recourse to the original half-tone negative a print is taken from the block on celluloid and dusted with blacklead or other opaque powder, so that it may be used as a negative to print the gelatine relief.

A more simple and ingenious process of strengthening the impression in the shadows and darker tones has been patented by Dr. E. Albert. It dispenses with the overlay, and consists of the application of a peculiar underlay. A sheet of thin zinc has an image of the picture transferred to it, possibly by simply taking a proof on it in an etching ink. This resist picture is strongly etched, so that the weaker tones are etched away, and the middle tones partially, the shadows being left intact. The result is a graduated plate, which is placed underneath the original etching, to-

gether with some cementing material, and the two subjected to great pressure whilst heated. When taken out the underlay is adherent to the printing plate, and the latter has been given a surface of varying relief, the shadows being highest. The block will therefore print without make-ready, and the author has seen excellent results produced in this way.

The only thing necessary now to be done with the half-tone plate, after it has been proved, is to mount it on wood to type height.

The margins, if left on, are trimmed off with circular saw or guillotine, and the nail holes made with a sharp pointed steel punch on the lead punching block. The holes are then countersunk with the hand-drill, and the plate placed in position on the wood block with a try square, applied to a straight side of the wood, and to any vertical or horizontal line on the picture. The mounting nails are then driven in about half way with the hammer. When all are inserted the nail guider (fig. 96) or the flat ended punch is applied to them and each driven home.

The block is next trimmed off near to the margins with the circular saw, and the sides squared up on the shoot-plane or the trimmer. The end grain should always be shot first, so that a sharp corner is left when the lengthwise cut is made. Those who have handled shoot-planes and trimmers know how difficult it is to avoid the corners breaking if the ends are shot last.

The trimmer must be run at its proper speed (about 4,000 on the spindle); the knives must be keen and set

at the right angle, and placed so that their points just skim the edge of the table.

The block must now be tried with the type high gauge, and if too high taken down with the rotary planer. If this machine is not available a long carpenter's plane known as a trying plane is used. To ensure the right height two accurately planed steel blocks should be placed fore and aft of the block to be planed, so that when the right height has been obtained the plane can take no more off, as it then rests on the steel blocks. If the block is too low, which it never should be, the only remedy will be to take the plate off and place a sheet of paper or cardboard between the plate and mount, though the usual practice is to leave the printer to paste an underlay on the bottom of the mount.

The photo-engraver who wishes to secure the friendship of the letterpress printer should see that his blocks are well mounted. It has been suggested that the plate should be mounted by gluing it, or by cementing it to the block, but though this will do well enough for the hand press it will not be safe for machine printing.

In some cases plates have to be cut close to the outline for mortising in to a design. In this case there is no room for nails, and soldering is not always convenient or neat. Resort is accordingly made to a system known as "anchoring." The principle will be grasped by referring to fig. 110. The head of the screw is tinned and soldered to the back of the plate. A special drill is used to make the shouldered hole in

the wood block, and a key or small pliers is used to turn the nut which draws the plate tight up to the block.

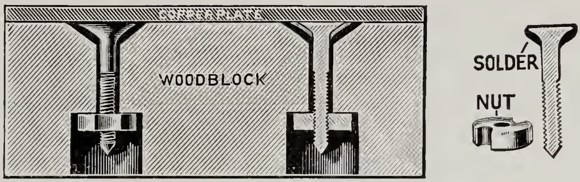


Fig. 110.

A word must be said about "laminated" backing. This consists of mounting wood made up of several layers with the grain crossed and cemented together under great pressure. This forms excellent mounting wood which does not warp. It is of course much dearer than the usual oak, mahogany, etc.

Type metal mounts are sometimes required, but the photo-engraver generally transfers that part of his order to the nearest electrotyper, who solders the plate on to the metal backing.

It has been suggested that etched zinc plates should be given an electrolytic coating of copper, brass, or nickel, so as to render them less liable to corrosion. This plan is quite practicable, and has several times been tried, but the trouble of working an additional process, and the fact that the customer would hardly care to pay anything extra for it, has deterred most photo-engravers from undertaking this further duty. Brass and nickel would have to be deposited with a battery. This does not involve a very expensive outfit, but it requires some time and care, together with experience, to get a good coating.

A superficial coating of copper may be applied to zinc plates by neutralising copper sulphate with a strong alkali, such as ammonia or cyanide. The plate is well washed and scrubbed with caustic potash and whiting, and is then immersed in this solution for a few minutes, when it will be found coated with a sufficient covering of copper. Copper plates may be made to look very presentable by immersing in a solution of cyanide and silver. A cyanide fixing bath which has been in use for some time for plates will do very well.

Special Three-Colour Process. André & Sleigh, Ltd., Bushey, Herts.

OPEN WORK LANTERN VASE FROM SALTING COLLECTION.
S.K. MUSEUM.

Example from "Chinese Porcelain," by permission of Cassell & Co., Ltd.

CHAPTER XV.

THE THREE-COLOUR HALF-TONE PROCESS.

Owing to the recent remarkable developments of trichromatic photography and its application to colour printing this book would hardly be considered complete without some reference being made to the way in which the half-tone process is applied in this direction. It is, however, quite outside the scope of this book to discuss the principles of the three-colour process, not only for want of space but because the subject has been ably dealt with by various other writers.*

It is sufficient to assume that the reader knows something of the principles of the process already and that he wishes to have information as to what variation is made in the half-tone process.

The additional apparatus required will be a set of colour filters or a glass cell in which coloured solutions are placed. Sets of colour filters can be bought ready made, viz., Lumière's for use in conjunction with the Lumière orthochromatic plates, Sanger Shepherd's for use with the Cadett Spectrum Plate, Carbutt's for use with Carbutt's plates, and Klein's for use with Dr. E. Albert's Collodion Emulsion. The latter filters are also made to order suitable for any kind of plates.

*"A Handbook of Photography in Colours" (Marion & Co.), can be recommended for study, also "Three Colour Photography" by Von Hübl.

Whichever set of filters is used provision must be made for affixing the filter plate behind or in front of the lens, for which purpose colour screen holders are made. The lenses I have already described for half-tone are equally good for colour work.

There are two ways in which the negatives may be made, viz.:

I. By making a set of orthochromatic negatives through the colour filters or colour sensitive plates; from these negatives a set of positives (transparencies); and from these positives a set of half-tone negatives.

II. By inserting the ruled screen in front of the plate and the colour filter behind the lens, thus making the half-tone and orthochromatic result at one time.

The advantage claimed for the first method is that the half-tone negatives can be made by the usual wet-plate process, and thereby the best half-tone results are attained. Any gain, however, in this direction is more than counterbalanced by the chances of error in the six preceding operations, and the second process is now being largely adopted.

This method involves the use of either colour sensitive dry plates or colour sensitised collodion emulsion. The latter method has an advantage in the fact that the operations are similar to wet collodion, and the negatives resemble those by this process, so that the printer is given no unusual task in printing them on to the metal. A printer who has been used to wet

plate negatives would certainly experience some difficulty in printing gelatine dry plates.

Mr. Sanger Shepherd recommends the Spectrum plates to be used for making the orthochromatic results, and the half-tones made by the wet plate process from positives, though he has suggested the possibility of direct colour and half-tone negatives combined. The ratio of exposures varies from various reasons, but an approximation is six for the red, three for the green, and two for the blue filter.

The transparencies are made by contact, and for making the half-tone negatives from them they are placed one by one in the end of a copying camera, opposite and near to a smooth whitened wall or sheet of white cardboard, which is strongly illuminated by the light of two arc lamps.

If the usual cross-lined screen ruled at an angle of 45° to the sides of the plate be used for all three half-tone negatives a pattern or moire effect will be produced. This can be overcome by turning the original by means of a rotary copyboard, or the sensitive plate or the screen by means of a three-way carrier (two remaining fixed while a third is turned), to an angle where the overlapping dots will form no pattern. But it is obvious that this will limit the effective size of the picture to such a rectangle only as can be got into a circle whose circumference touches the edges of the screen.

To avoid this drawback it is found best in practice to have two screens of the maximum size desired, one ruled with the lines parallel to the two sides and the

other with the lines at 60° and 120° to the sides. The latter screen is reversed for one of the exposures, and to enable this to be done it is of course necessary that the glass on which the screen is ruled should be as nearly as possible uniform in thickness on both sides. These paired screens are equally useful for the direct or indirect process.

The diaphragms used may be the same as in the ordinary half-tone process, and the same rules as to screen distance apply. The square diaphragm must of course be turned to agree with the angle of the screen. To promote a greater action in one direction than another a stop as here illustrated (fig. 111) is used. Its effect is to make elliptical dots in chain-like lines, according to the direction of the elongations. It is placed in a different direction for each colour.

Fig. 111.

Messrs. Howard Farmer and Guy Symmons, of the Polytechnic, London, have worked out a direct process with Lumière's plates, and the published results are very good. Liquid filters are employed, the composition of the dyes being as follows:

Stock Solutions.

Potassium chromate (yellow)	1,200 grains
Water sufficient to make total bulk ...	10 ounces
Potassium bichromate (red)	300 grains
Water sufficient to make total bulk	10 ounces

Eosine (blue shade)	120 grains
Water	10 ounces
Methylene blue	5 grains
Water	10 ounces

All these solutions are filtered several times or allowed to stand several days and the clear portions decanted.

Filter for yellow printing negative.

Eosine (blue shade) stock solution	180 minims
Water	20 ounces

Filter for crimson printing negative.

Potassium chromate stock solution ...	300 minims
Methylene blue	110 ,,
Water	20 ounces

Filter for blue printing negative.

Potassium bichromate stock solution ...	20 ounces
Eosine (blue shade)	250 minims
Ammonia .880	250 ,,

The ammonia is to redissolve the precipitate formed by the eosine when added to the bichromate solution.

The cells used are ¼in. section.

For the yellow printing negative a Mawson lantern plate is used.

For the crimson printing negative a series A Lumière plate is used.

For the blue printing negative a series B Lumière plate is used.

The plates are heated on an electric heater up to 220°F., and then backed. Development is with hydroquinone. The exposures are comparatively rapid.

The succeeding operations are in accordance with the usual practice of the half-tone process.*

A. A. K. Tallent recommends the following simple formulæ for filters suitable for working with Cadett Spectrum Plates or Lumière's Panchromatic: Only three dyestuffs are required—brilliant yellow, naphthol green, and methyl blue. The filter for the red record negative is made by a strong solution of brilliant yellow, of a reddish orange colour (a little fuchsin may be added with advantage). The green filter is made up of a strong solution of naphthol green and brilliant yellow until a yellowish green colour is produced. The blue filter is composed of naphthol green and methyl blue. These filters confine the action in the negatives to the part desired and cut off the ultra-violet. The above three dyes make a good starting point for experiment.

For fuller information reference should be made to Mr. F. E. Ives's demonstration of colour screen making in the *Photographic Journal*, vol. xx., No. 11.

Baron von Hubl, a recognised Continental authority and the author of *Die Dreifarben Photographie*, recommends the following solutions for the filters:

Green filter for red printing plate.

Acid green (1 : 10,000 solution)	60 grains.
Potassium bichromate (1 : 150 solution)...	272 minims.
Water	85 minims.

Red filter for the blue printing plate.

Biebrich scarlet (1 : 500 solution)	q.s.

Blue filter for the yellow printing plate.

Pyoktanin (1 : 20,000 solution)	q.s.

*Full details are given in Mr. Howard Farmer's paper before the Royal Photographic Society, May, 1901; *Journal* No. 10, vol. xxv., pp. 294/308.

The above strengths are for a cell with ($\frac{3}{16}$in.) separation between the glasses.

Von Hubl recommends various other solutions depending on the nature of the sensitive plates used.

Collodion emulsion offers great advantages for three-colour work owing to the facility with which it can be sensitised for different portions of the spectrum by the admixture of suitable dyes. Dr. E. Albert's collodion emulsion affords a convenient means, ready to hand, of making three-colour negatives, and there have now been introduced upon the market suitable sensitisers for it as well as screens of the proper absorption value. These screens, known as Klein's Colour Filters, do not cut out all the rays except those intended to act, but rely on the insensitiveness of the plate to the other rays. In this way a comparatively transparent colour filter is obtained which does not require unduly long exposures. There are three sensitisers marked respectively A, B, and C. The exact composition of the solutions is a secret, but it is understood that the first two are eosin-silver compounds, and the third is a cyanin-silver compound. They are either added to the emulsion or flowed on the plate before exposure. The exposures will vary with the nature of the illumination, but will be approximately 1 : 0·5 : 5 for the blue-violet, green, and red filter respectively. Direct half-tone and chromatic negatives may be made, or the more roundabout way of making chromatic negatives, positives, and half-tone negatives.

By whatever process the chromatic negative result is obtained the routine will resolve itself into the ordinary

half-tone process, when the stage is reached of printing the negative on to the metal and etching. Great care, however, must be taken to get the three prints of equal tone value, and the same relation must be preserved in the etching. It would not do, for instance, to over-print or over-etch one of the results. The most perfect system would be to expose all three plates at one operation, develop all three negatives at one time, and to print and etch all at the same time. There are great difficulties in the way of attaining such an ideal result, *e.g.*, the widely different exposures through the three filters; the different density values in the negatives made from differently sensitised emulsions; differences (though, maybe, slight) in the joining-up of the dots in the half-tone negative, requiring therefore longer or shorter exposure in the printing; and finally the fact that the colour values in the respective plates require somewhat different treatment in the etching. The half-tone process must necessarily lower the key of the colour values, and the contrast must be brought back by judicious fine-etching. Colour results claiming to be done without fine-etching generally give one the impression that a little of it would have improved the result.

Three-colour work is one of those things for which no set rules can be given. The worker must first be a skilful craftsman in the black and white half-tone process, and especially a good photographer. Then he only requires a good set of colour filters and colour sensitive plates of good repute to start him on the right path which will lead him to a successful issue, if he

follows it with a definite aim, and adheres to rules and principles given him either by the plate makers or by the filter makers.

A word must be said in conclusion about the inks with which the blocks are to be printed. Here the worker will most likely encounter his greatest pitfall, and to avoid it he should make careful preliminary enquiry as to the inks recommended as suitable for given filters.

The difficulty is that no inks have yet been discovered which will render the colours of nature perfectly in three printings, yet a sufficiently close approximation can be obtained for all practical purposes. The inks nearest to theoretical requirements are unfortunately not permanent, being aniline colours, but they are sufficiently so for use as book illustrations or other purposes where they will not be exposed to strong light. The permanent inks are not so transparent nor so correct in colour rendering, yet they come very near to the required standard, and most printers prefer to use them. A slight correction of colour values in the blocks can be made to allow for any excessive strength of one colour over another.

Some ink makers send out a "mixing white" for reducing the intensity of any particular ink, but such a course is not to be recommended.

It is a good plan to make a tri-colour transparency, to test the quality of the negatives, by the Sanger-Shepherd, Lumière, or other method of staining or superimposing films. This will soon show if the negatives are incorrect, and will save the tedious operations of making blocks and proofing them.

INDEX.

ERRATA.

The illustrations of mirror box (fig. 26 on page 69) and prism (fig. 24 on page 66) have been accidentally transposed.

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See opposite page.